semiconductorTODAY

COMPOUNDS & ADVANCED SILICON

www.semiconductor-today.com

Join our LinkedIn group: Semiconductor Today

Follow us on Twitter: Semiconductor_T

Choose *Semiconductor Today* for . . .

MAGAZINE

Accurate and timely coverage of the compound semiconductor and advanced silicon industries

Targeted 82,000+ international circulation

Published 10 times a year and delivered by e-mail and RSS feeds

WEB SITE

Average of over 26,000 unique visitors to the site each month

Daily news updates and regular feature articles

Google-listed news source

E-BRIEF

Weekly round-up of key business and technical news

E-mail delivery to entire circulation

Banner and text marketing opportunities available

ISSN 1752-2935 (online)

semiconductorTODAY

COMPOUNDS & ADVANCED SILICON

Vol. 17 • Issue 3 • April/May 2022

www.semiconductor-today.com

Wolfspeed opens 200mm silicon carbide device fab

Navitas joins PowerAmerica consortium • Ayar Labs raises $130m • ams OSRAM investing €800m in new 8" LED front-end fab

IQE

THE GLOBAL LEADER IN EPIWAFER SUPPLY

Enabling the Best RF, Photonics & Power Semiconductors

- 'One-stop-shop' for III-V & Silicon epiwafer products
- 2" to 6" epitaxy ready substrates & polycrystalline materials
- Multiple manufacturing sites; Europe, Asia & America
- Leveraging 30+ years of compound semiconductor IP
- Custom engineered structures; R&D to production volumes

RF

GaN HEMT
5G Infrastructure
Radar, EW/ECM, & SATCOM

GaAs HBT / pHEMT / BiHEMT
5G Smartphones & Infrastructure
WiFi6 Hotspots, GPS & IoT

SiGe HBT
5G Smartphones
WiFi6, Bluetooth, GPS & IoT

PHOTONICS

InP Laser & Detector
Optical Comms & Data Centres
SW IR Imaging

GaSb Laser & Detector
MW-LW IR imaging
Biometrics

GaAs VCSEL
3D Sensing & LiDAR
Datacoms

POWER

GaN on Si HEMT
GaN on GaN
Electric Vehicle Systems
Power Conversion & Storage

GaAs Multi-Junction Solar
High Efficiency Terrestrial CPV & Space PV

GaN LED & Laser
MicroLED Display & AR/VR
UV Sterilisation

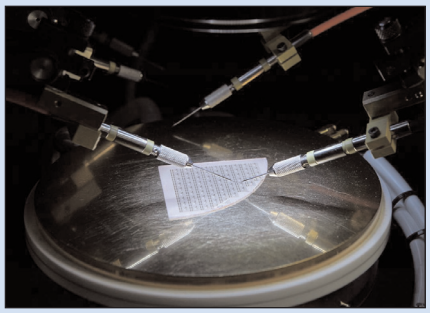
EUROPE: +44 2920 839 400
AMERICAS: +1 508 824 6696
APAC: +886 3 579 8181
ALL INQUIRIES: sales@iqep.com

www.iqep.com

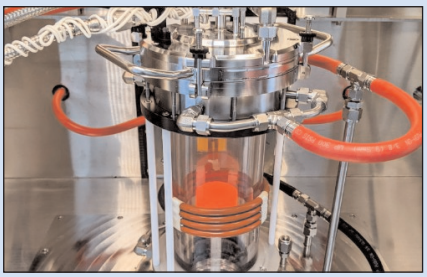
contents

semiconductorTODAY
COMPOUNDS & ADVANCED SILICON

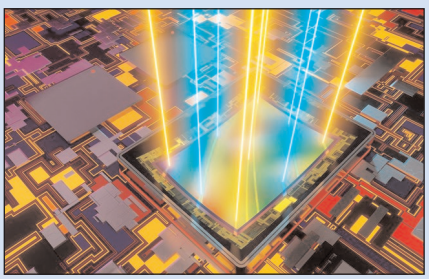
Vol. 17 • Issue 3 • April/May 2022



p18 Penn State University is leading a five-year, $7.5m US Department of Defense study of radiation effects on wide-bandgap semiconductors.



p33 The University of Bristol has installed the UK's first MOCVD system for the epitaxial deposition of Ga_2O_3.



p60 The EU-funded project INSPIRE is combining SiN and InP in hybrid photonic integrated circuits by using wafer-scale micro-transfer printing.

Cover: Wolfspeed has officially opened its Mohawk Valley 200mm silicon carbide device fabrication plant in Marcy, NY with a ribbon-cutting by a Lucid Air Grand Touring electric car, which will use Wolfspeed power modules in its inverter. **p12**

editorial

Power electronics conversion from silicon to SiC and GaN

On 25 April, North Carolina-based Wolfspeed officially opened its silicon carbide Mohawk Valley Fab in Marcy, NY, USA, with the 'ribbon-cutting' performed by a Lucid Air Grand Touring electric vehicle (EV) — see page 12 and cover picture. The world's first 200mm-wafer SiC device fab — together with a new materials factory at the firm's base in Durham, NC (due to be completed later this year) — comprise a 'silicon carbide corridor' on the USA's East Coast, addressing a $20bn+ opportunity pipeline for SiC devices (driving the firm's design-ins to $1.6bn in March-quarter 2022).

Lucid Motors aims to challenge the increasingly ubiquitous Tesla, and is using Wolfspeed's 1200V SiC power modules in the inverters of its Lucid Air car. The EV maker has agreed a multi-year deal for Wolfspeed to supply it with SiC power devices, produced at Mohawk Valley.

The clearest benefit of the switch-over from internal-combustion engines to electric vehicles is the effect of lower CO_2 emissions into the atmosphere. Although battery charging still involves power generated from fossil fuels, the inherent efficiencies of EVs alone yields a reduction in the use of oil and gas (even more significant now that Europe and 'the West' are urgently aiming to reduce their dependence on supplies from Russia). Europe (particularly Germany) is also a focus of EV technology and production, both native (in BMW, Mercedes, VW Group) and from abroad (with Tesla opening its 'Gigafactory Berlin-Brandenburg' on 22 March).

Apart from the inherent efficiencies of EVs in the motor/power-train, efficiencies in the power-conversion electronics are being boosted by the rapid migration from silicon to silicon carbide.

The step-change in end-application is driving demand up through the supply chain. Wolfspeed's vertically integrated business model extends from in-house manufacturing of its own SiC substrates through to module manufacture (and it can invest in its own production capacity at the various stages of the supply chain commensurately). Other firms have been extending their capabilities either down the chain (e.g. SiC substrate maker II-VI Inc licensing device and module technology from GE) or up the chain, to secure sources of supply - Japan-based epiwafer maker Showa Denko recently started in-house mass production of its own 6-inch SiC substrates (stemming from its takeover in 2018 of the SiC-wafer-related assets of Nippon Steel), supplementing its established merchant suppliers of SiC substrates (see page 15).

In addition to SiC, the operating voltages of gallium nitride (GaN) devices may ultimately be extended to power electronics applications in EVs. For example, at the International Symposium on Power Semiconductor Devices and ICs (ISPSD 2022) in late May, Transphorm is detailing R&D results from its 1200V GaN power transistor (see page 28). Meanwhile, Japan's ROHM has partnered on developing 600V GaN devices with power supply maker Delta Electronics (page 21). Ultimately, as well as discrete GaN HEMT devices, even GaN integrated circuits can now be extended from consumer electronics to power electronics applications, as indicated by GaN power IC firm Navitas joining the Power America consortium (see page 24).

Mark Telford, Editor
mark@semiconductor-today.com

semiconductorTODAY
COMPOUNDS & ADVANCED SILICON

Editor
Mark Telford
Tel: +44 (0)1869 811 577
Cell: +44 (0)7944 455 602
Fax:+44 (0)1242 291 482
E-mail: mark@semiconductor-today.com

Commercial Director/Assistant Editor
Darren Cummings
Tel: +44 (0)121 288 0779
Cell:+44 (0)7990 623 395
Fax:+44 (0)1242 291 482
E-mail: darren@semiconductor-today.com

Advertisement Sales
Darren Cummings
Tel: +44 (0)121 288 0779
Cell:+44 (0)7990 623 395
Fax:+44 (0)1242 291 482
E-mail: darren@semiconductor-today.com

Original design Paul Johnson
www.higgs-boson.com

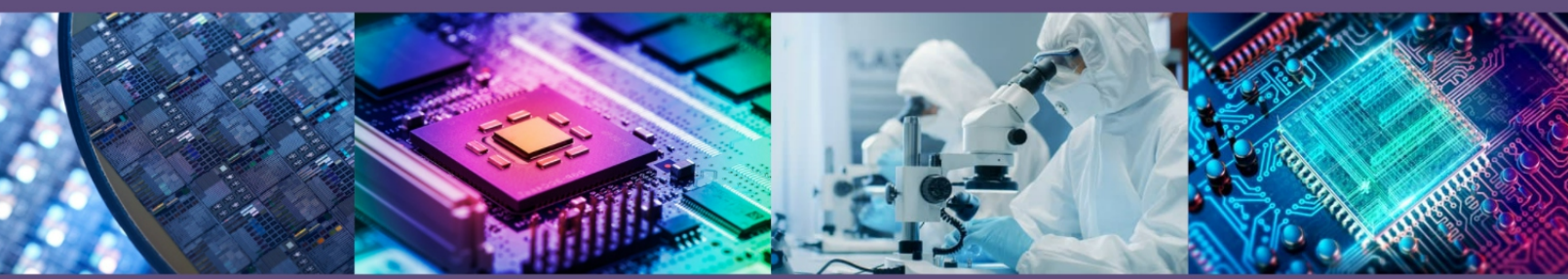
***Semiconductor Today* covers the R&D and manufacturing of compound semiconductor and advanced silicon materials and devices** (e.g. GaAs, InP and SiGe wafers, chips and modules for microelectronic and optoelectronic devices such as RFICs, lasers and LEDs in wireless and optical communications, etc).

Regular issues contain:
- news (funding, personnel, facilities, technology, applications and markets);
- feature articles (technology, markets, regional profiles);
- conference reports;
- event calendar and event previews;
- suppliers' directory.

***Semiconductor Today* (ISSN 1752-2935) is published free of subscription charge** in a digital format 10 times per year by Juno Publishing and Media Solutions Ltd, Suite no. 133, 20 Winchcombe Street, Cheltenham GL52 2LY, UK. See: www.semiconductor-today.com/subscribe.htm

csconnected

THE WORLD'S FIRST COMPOUND SEMICONDUCTOR CLUSTER



CSconnected is home to the world’s first regional ecosystem based on the manufacture of compound semiconductor enabled hardware, located in south Wales

Driving tomorrow's technologies

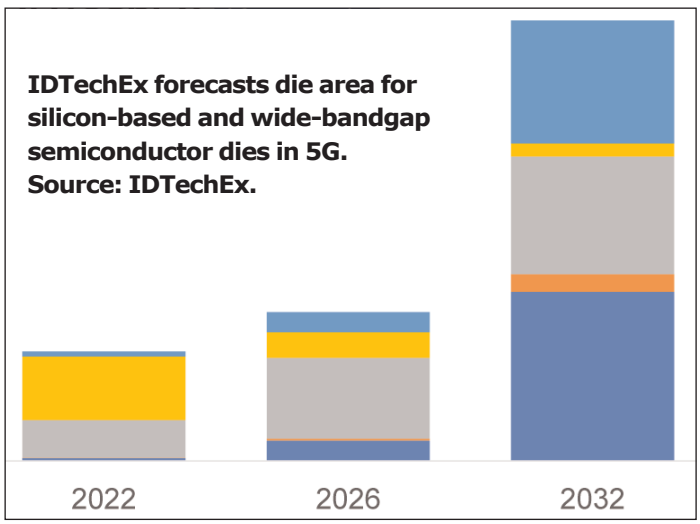
csconnected.com | info@csconnected.com

5G a significant market opportunity for GaN

Significant uptake in GaN expected over next decade for higher end of sub-6GHz infrastructure

Much of the 5G rollout to date has been in frequency bands more similar to existing 4G rather than taking full advantage of 5G's higher frequencies, notes IDTechEx's latest research report 'Thermal Management for 5G 2022–2032'. The existing state of 5G has seen less technological innovation than might have initially been expected, with the promise of high-frequency, Gigabit download speeds, and millisecond latency yet to be realized in a major way. There is certainly more scope for technical development and hence opportunities for several technologies and materials, a critical one of which is wide-bandgap semiconductors, says IDTechEx. In particular, gallium nitride (GaN) has a significant opportunity within the 5G market, and this creates a downstream effect on other components such as die attach materials, the report adds.

LDMOS (laterally diffused metal-oxide semiconductor) devices have been the technology of choice for power amplifiers through the 4G era. These power amplifiers provide the crucial role of boosting the signal for transmission. The trouble is that, above about 4GHz, LDMOS starts to become inefficient (critical for telecoms infrastructure, as it directly impacts the energy consumption of the antenna). With much of 5G infrastructure being deployed alongside existing equipment, the energy consumption of telecoms towers is set to increase dramatically. The adoption of wide-bandgap semiconductors like GaN is one method for reducing this future impact. GaN provides greatly improved efficiency at higher frequencies (10% or more improvement, depending on the specific use-case).



IDTechEx forecasts die area for silicon-based and wide-bandgap semiconductor dies in 5G. Source: IDTechEx.

GaN started being deployed in 4G networks with Huawei equipment, but it has seen only moderate adoption globally so far due to the increased price, lower manufacturing availability, and difficulty in integration with other components. However, it is far from niche technology developed by startup companies. For example, Japanese technology giant Sumitomo provides RF components to companies like Huawei including their GaN devices. With the growth of 5G continuing, especially for higher frequencies, IDTechEx expects a significant uptake in GaN over the next decade, especially for the higher end of the sub-6GHz infrastructure where higher powers are being used and component integration is not quite as challenging as it is in the millimeter-wave (mmWave) region. For this application, IDTechEx predicts a four-fold increase in GaN demand per year by the end of the decade.

The adoption of wide-bandgap semiconductors typically raises the junction temperature of devices and starts to bring more thermal management considerations. One critical failure point with thermal cycling is how the semiconductor device is connected, or the die attach material. Junction temperatures for GaN devices are often above 175°C. At this point we start to limit the options for typical solder materials, especially when lead-free is a requirement in most markets.

This is leading many players to consider sintering materials. Sintering involves the application of a (typically silver) paste that is heated, causing densification. The upshot is a more reliable connection with improved thermal conductivity. This has already started to be adopted in a big way in the electric vehicle (EV) market due to the transition to silicon carbide (SiC) and 800V platforms.

The key limitation historically has been the lack of commercial experience, long curing times, and the need for an inert atmosphere or higher pressures, but developments of these materials, greater market adoption, and the trend towards GaN could see sintering start to make a big impact in the 5G market too. IDTechEx expects a 10-fold increase in demand for sintering materials in 5G infrastructure by 2030. There is also great interest in the development of copper sintering materials rather than silver (due to the potentially reduced costs and improved performance), but this encounters the same issues that silver sintering had originally compared with solder.

www.idtechex.com

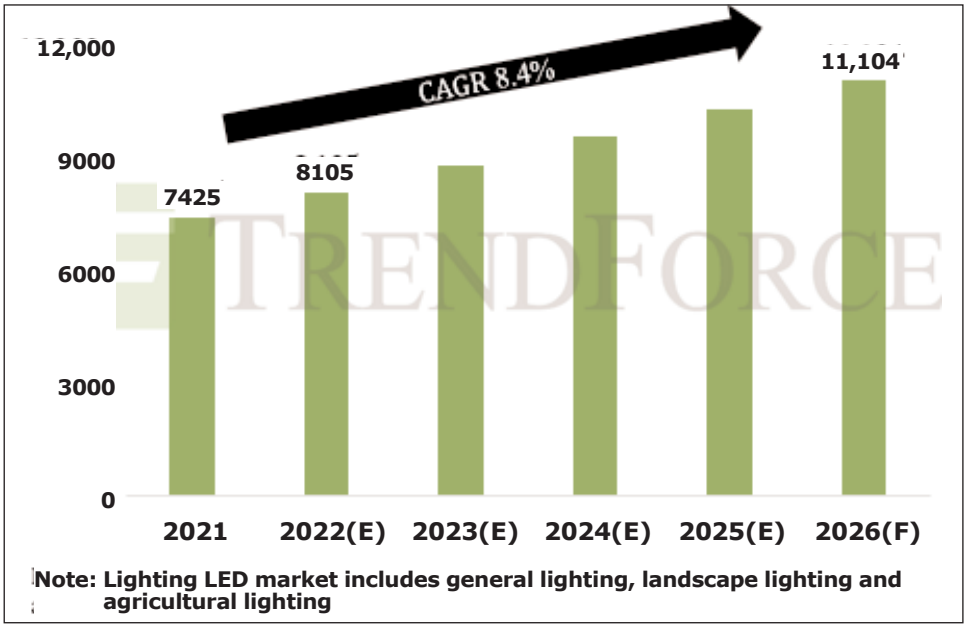
LED lighting market growing at 8.4% to $11.1bn in 2026

Human-centric lighting and smart lighting to drive growth

According to TrendForce's 'Global LED Industry Data Base and LED Player Movement Quarterly Update' report, demand for high-standard LED products in the lighting market is entering a growth stage. Generally speaking, the price of lighting LED products is stable. However, due to the recent rise in global raw material prices, the unit price of products looks to be trending higher. Coupled with high demand for energy conservation from governments around the world, the output value of the lighting LED market in 2022 is forecast grow by 9.2% year-on-year to $8.11bn. In the next few years, the scale of the lighting LED market will continue growing due to the promotion of human-centric lighting (HCL), smart lighting and other factors, and is estimated to be rising at a compound annual growth rate (CAGR) of 8.4% from 2021 to $11.1bn in 2026, adds the report.

TrendForce further states that, despite the continuing impact of the COVID-19 pandemic in 2022, the pervasiveness of vaccines and the recovery of economic activity coupled with the rigid demand associated with the lighting market as a daily necessity, global 'carbon neutrality', and the growing requirements of the energy conservation agenda, have moved numerous major powers to realize net-zero emission through measures such as energy efficiency and low-carbon heating in recent years.

However, lighting is a leading energy consumer in buildings, accounting for 20–30% of total building energy consumption. LED penetration will hence deepen, driven by high demand for energy conservation and policies and regulations requiring the upgrade of aging equipment. Also, smart lighting can achieve the purpose of timely energy conservation. Therefore, there is strong demand for the introduction of LED lighting and smart lighting upgrades in commercial lighting, residential lighting, outdoor lighting and industrial lighting, which further drives demand for high-standard LED products including high light efficiency, high color rendering and color saturation, low blue-light human-centric lighting and smart lighting devices.



Note: Lighting LED market includes general lighting, landscape lighting and agricultural lighting

Table 1: Lighting LED revenue ranking, 2020–2021.

Rank	2020	2021
1	MLS	MLS
2	Samsung LED	Samsung LED
3	Lumileds	Lumileds
4	Nichia	Hongli
5	CREE LED	Nichia
6	Hongli	CREE LED
7	Seoul Semiconductor	Seoul Semiconductor

The gradual recovery of the lighting market is clearly reflected in 2021 manufacturer revenue rankings. Lighting LED manufacturers including Samsung LED, ams OSRAM, Cree LED, Lumileds, Seoul Semiconductor, MLS, and Lightning have all posted revenue growth. MLS is still the leading manufacturer of lighting LEDs, ranking first in revenue, with an annual growth rate of 34% in 2021. ams OSRAM, Lumileds, Cree LED and Samsung LED primarily took advantage of orders for industrial, outdoor and horticultural lighting last year, posting annual revenue growth of 26%, 18% and 8%, respectively.

In terms of pricing, as demand in the lighting industry gradually recovered in 2021, facing demand for higher-specification terminal application products and the impact of rising overall costs in raw materials and operations, LED packaging factories no longer adopted pricing strategies to capture additional market share, allowing lighting LED product pricing to stabilize and rebound in 2021.

In terms of product categories, the average market price of medium- and low-power lighting LED products (less than 1W, excluding 1W) such as 2835 LED, 3030 LED and 5630 LED, posted an annual growth rate of 2.1–4.4%. For high-power lighting LED products (above 1W) such as ceramic substrate LEDs and 7070 LEDs, average annual market price growth was as much as 3–6%. TrendForce expects lighting LED pricing to further stabilize in first-half 2022.

www.trendforce.com

Smartphone production forecast for 2022 downgraded from 1.38 billion to 1.366 billion units after weak Q1 demand

Decline of 7.7% in China to reduce global annual growth to 2.5%

Due to lower-than-expected sales in fourth-quarter 2021, the smartphone market in first-quarter 2022 not only needed to adjust its accumulated inventory of finished products but it was also affected by sluggish seasonal demand, resulting in relatively weak Q1/2022 production performance, according to market research firm TrendForce. Coupled with the impact of recent events such as the Russian–Ukrainian war and lockdowns of Chinese cities, overall production performance in first-half 2022 will weaken, affecting total production in 2022. The original forecast of 1.38 billion units produced will be downgraded to 1.366 billion units, with the annual growth rate slipping to 2.5%. Neither the COVID-19 pandemic nor the shortage of wafer production capacity has been significantly alleviated. This, coupled with serious issues involving geopolitics, inflation and energy shortages this year, will generate variables in the smartphone market for 2022. Therefore, further downward revision of total 2022 production volume cannot be ruled out.

There are two key observations regarding the impact of the war on the smartphone market. First, brand sales have been suspended or have dropped sharply. According to TrendForce statistics, mobile phone sales in Russia and Ukraine account for 3–4% of global market share, 85% of which are in the Russian market, with Samsung, Xiaomi and Apple as the top three Russian mobile phone brands. Since Apple and Samsung announced the suspension of all exports to Russia, vacated market share will migrate to Chinese brands. If the war can be brought under control before the end of April, the estimated impact on the smartphone market in 2022 will be about 20 million units.

Second, the war has exacerbated global inflation, which is strongly affecting energy and food prices in particular and is rapidly spreading from Europe to the world. This also implies that personal disposable income will shrink simultaneously, resulting in a prolonged replacement cycle in the smartphone market and phenomena such as falling budgets for stand-alone purchases. Due to inflation's broad and profound influence, it is not yet possible to determine the extent of its impact on the global smartphone market but there is indeed a high risk of downward revisions in the future.

It should be noted, in addition to the war, the pandemic will continue to affect smartphone market trends in 2022. China, the world's largest smartphone consumer market, is still adopting a dynamic zero-COVID policy. Not only will this policy exacerbate manpower and material shortages in the intricate smartphone supply chain, pandemic prevention activities will also throw cold water on demand, TrendForce believes. Given China's short-term economic growth rate, the current forecast for China's smartphone market shipments will drop from about 325 million units last year to 300 million units, representing an annual decline of about 7.7%, and a possibility of a continued downturn, the market research firm forecasts.

https://insider.trendforce.com

Smartphone shipments fall year-on-year for third consecutive quarter, by 11% to 314 million in Q1/2022

Samsung achieves highest smartphone market share in five years

Global smartphone shipments fell by 11% year-on-year to 314 million units in first-quarter 2022 (the third consecutive quarter of annual decline by smartphone volumes), according to market research firm Strategy Analytics.

"Factory constraints and component shortages continued to restrict smartphone supply in the first quarter of this year," notes senior director Linda Sui. "Meanwhile, unfavorable economic conditions, geopolitical issues, as well as COVID-19 disruption (China rolling lockdown etc) continued to weaken consumers' demand on smartphones and other non-essential products."

Samsung's 75 million smartphone shipments yielded the top market share of 24% (its highest first-quarter performance over the past five years, since 2017). "Demand was strong for the newly launched flagship Galaxy S22 series, especially the higher-priced S22 Ultra model," says Woody Oh, director at Strategy Analytics. "Meanwhile, Samsung continue to ramp up the mass-market A series in multiple markets.

Apple shipped 57 million iPhones (up 1% year-on-year), yielding 18% market share (ranking second). "Apple had a good quarter, led by iPhone 13 series and the newly launched iPhone SE (2022), which starts to become a volume driver in lower segment," notes Oh. "Apple also captured the highest first-quarter market share since 2013, at the expense of leading Chinese brands, who are hampered by the sluggish home market."

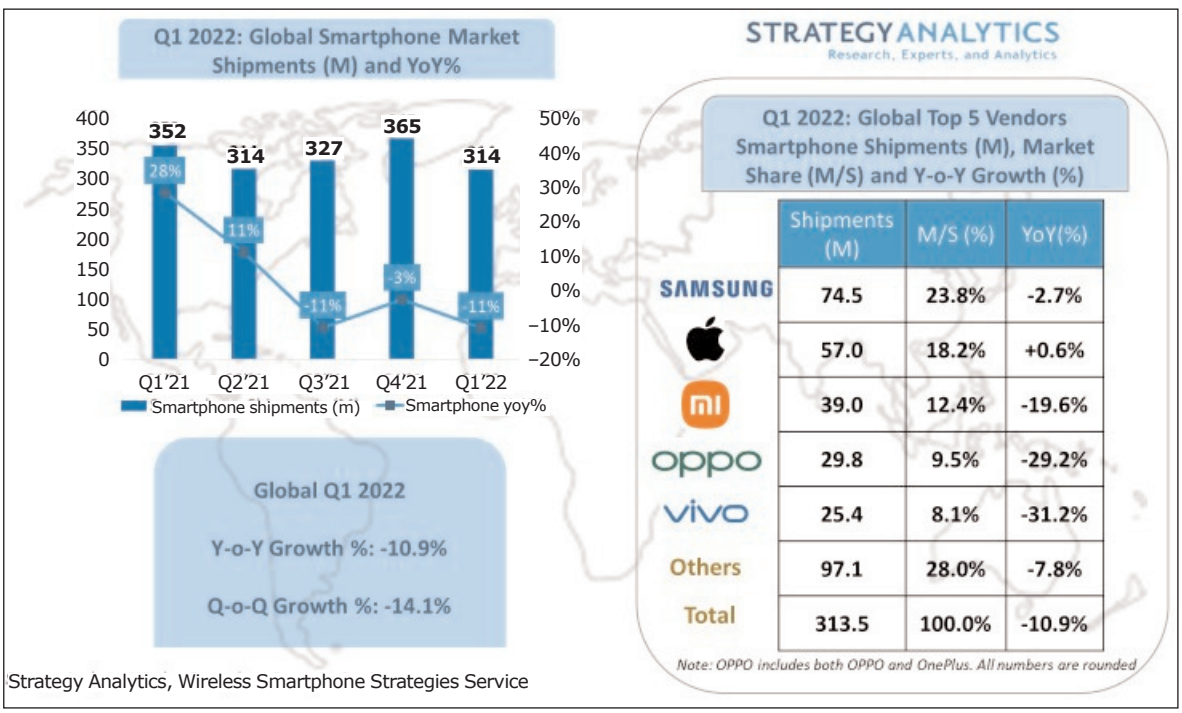
Nevertheless, Xiaomi, OPPO (including OnePlus) and vivo remained in the top five.

Xiaomi shipped 39 million smartphones, yielding third place with 12% market share (down from 14% a year ago). "Xiaomi suffered from the geopolitical uncertainties in Europe," says senior analyst Yiwen Wu. "China and India market also delivered a mixed bag for the Chinese brand." OPPO (OnePlus) held fourth place, with 10% market share. Vivo remained fifth, with 8% market share. "OPPO (OnePlus) and Vivo both lost ground in all key markets except Latin America, as 5G competition from Honor and other smartphone competitors intensified sharply in China and other markets," adds Wu.

"Global competition among other major smartphone brands, beyond the top-five, was fierce during Q1/2022," comments executive director Neil Mawston. "Honor, Realme, Lenovo-Motorola and Transsion all outperformed the overall market but delivered different patterns. Honor held firm in China and continued to ramp up in overseas markets. Realme continued the upwards track in all regions, but China pulled back the overall performance. Lenovo-Motorola gained share in the North America but the momentum in Central Latin America has been disrupted by other Chinese brands. Transsion faced the intensified competition from Samsung in Africa region, posting the annual decline in the region for the first time over the past two years," he adds.

Strategy Analytics forecasts that global smartphone shipments to contract by 1-2% year-on-year in full-year 2022. "This year will be a tale of two halves," expects Sui. "Geopolitical issues, component shortages, price inflation, exchange rate volatility, and COVID disruption will continue to weigh on the smartphone market during the first half of 2022, before the situation eases in the second half due to Covid vaccines, interest rate rises by central banks, and less supply disruption at factories."

www.strategyanalytics.com



Strategy Analytics, Wireless Smartphone Strategies Service

Qorvo announces chief financial officer transition

Vice president of treasury Grant Brown made interim CFO as Mark Murphy leaves to be CFO of Micron

Qorvo Inc of Greensboro, NC, USA (which provides core technologies and RF solutions for mobile, infrastructure and defense applications) says that, after being appointed chief financial officer in June 2016, Mark Murphy is leaving the firm, effective 18 April, to join Micron Technology Inc as its CFO.

Qorvo has initiated a comprehensive search for a new CFO. Vice president of treasury Grant Brown has been named interim CFO through the transition period.

"On behalf of the board of directors and Qorvo's management team, we thank Mark for his many contributions to Qorvo," says CEO Bob Bruggeworth. "Qorvo has built a high-performing finance team under

Mark Murphy (left), now CFO of Micron, and new CFO Grant Brown (right).

Mark that has been critical to executing our strategic priorities," he adds.

"Grant has been with Qorvo for many years and has been a key part of our disciplined growth, leading various functions in our finance team," notes Bruggeworth. "He has extensive knowledge of our business and is uniquely positioned to support Qorvo during this period as we deliver on our financial and strategic initiatives."

The firm's guidance for its fiscal fourth-quarter 2022 (provided on 2 February) remains unchanged.

www.qorvo.com

Altum RF uses WIN's latest 0.1µm GaAs pHEMT technology for amplifiers covering Q-, V- & E-bands

Compact MMIC amplifiers achieve high gain and low noise with ease of use for design-in

Altum RF of Eindhoven, The Netherlands (which designs high-performance RF to millimeter-wave solutions for commercial and industrial applications) has announced three new gallium arsenide (GaAs) pHEMT monolithic microwave integrated circuit (MMIC) amplifiers targeting applications covering Q-, V- and E-bands. Using the PP10-20 GaAs pseudomorphic high-electron-mobility transistor (pHEMT) technology of WIN Semiconductors Corp of Taoyuan City, Taiwan – the largest pure-play compound semiconductor wafer foundry – the compact die amplifiers are said to achieve high gain and low noise, while simplifying design-in for engineers by using single-gate and single-drain supplies.

Highlights of the amplifiers include:

- ARF1208 low-noise amplifier — 37–59GHz, 2.5dB noise figure and 26.5 dB linear gain at 50GHz
- ARF1207 linear amplifier — 57–71GHz, 25dB gain and 22dBm P1dB output power;
- ARF1206 low-noise amplifier — 71–86GHz, 22dB gain and 4dB noise figure.

"This next-generation PP10-20 technology builds upon the mature PP10-10 platform used in many of today's E-band power amplifiers deployed in wireless backhaul," notes David Danzilio, senior VP, technology and strategic business development at WIN. As a key differentiator, PP10-20 allows for a substantial increase in gain, with the same operating voltage for power applications. "PP10-20 is a versatile technology enabling a wide range of millimeter-wave front-end functions and supports amplifier performance well into D-band," he adds.

"Building on our experience with WIN's proven 0.1µm technology and with careful attention to modeling, design and simulation workflow, we achieved first-pass success with a family of millimeter-wave products in the newly released PP10-20 process," says Altum RF's CEO Greg Baker. This "supports our strategy to develop leading-edge components for millimeter-wave applications, and we look forward to building a broader portfolio of products to address today's and future market requirements," he adds.

"The first-pass success achieved by Altum RF confirms the reproducibility and production readiness of the PP10-20 platform," says Danzilio.

www.altumrf.com

Filtronic signs Ormic as Israel sales rep

Market for amplifiers, transceivers, waveguides and filters extended to Israeli aerospace & defence and telecoms sectors

Filtronic plc of Sedgefield and Leeds, UK — which designs and manufactures RF, microwave and millimeter-wave (mmWave) components and subsystems — has signed a sales representative agreement with Ormic Components Ltd of Modi'in Technological Park, Israel.

Filtronic says that Ormic has a proven track record of selling high-performance mission-critical equipment to the Israeli aerospace & defence industry, as well as to other critical communication sectors including telecommunications. Founded in 1997, Ormic is said to be a trusted source for RF/microwave modules, including front-ends, amplifiers and transceivers.

Filtronic offers amplifiers, transceivers, waveguides and filters, and its capabilities across the entire RF spectrum (including mmWave) are complementary to Ormic's client base and technology portfolio. Filtronic's proven capability to develop high-performance custom solutions for complex RF problems allows Ormic to extend its homeland security business, and will help it to further enhance its position within Israel's aerospace, defence and telecom industries.

"Ormic's existing client base and laser-focused approach to sales channel development will create new opportunities for Filtronic," believes Jerry Sanham, Filtronic's director of business development.

"Our partnership with Filtronic provides us access not only to key mmWave products but also to their strong capabilities in hybrid and RF design and manufacturing," comments Ormic's managing director Ron Mizrahi.

Filtronic exhibited at European Microwave Week (EuMW 2021) in London (2–7 April).

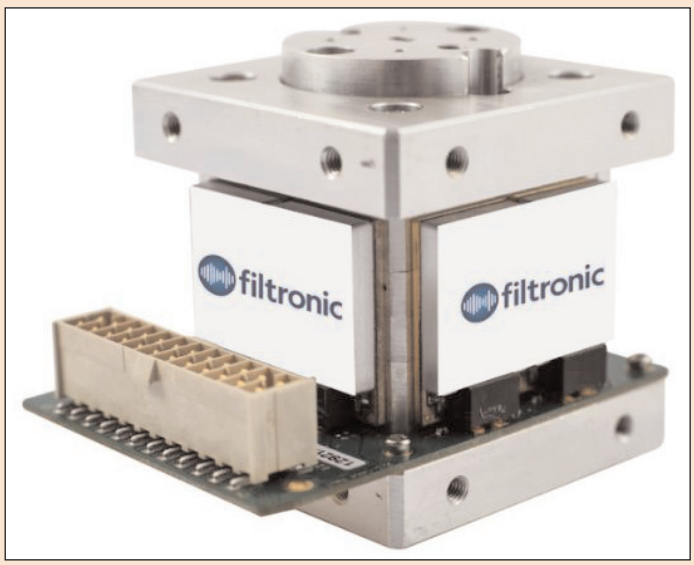
www.eumweek.com
www.ormiccomponents.com
www.filtronic.com

Filtronic introduces E-band high-power amplifiers for long-range telecoms links

GaAs HEMT power amplifier MMICs suit LEO and HAPS applications

Filtronic plc of Sedgefield and London, UK — which designs and manufactures RF, microwave and millimeter-wave (mmWave) components and subsystems — has announced the availability of the extended Cerus range of high-power E-band amplifiers designed for long-range commercial or military telecommunications applications, including low Earth orbit (LEO) and high-altitude platform systems (HAPS).

The high-power Cerus range is now available in 1-, 4- and 8-way amplifier versions. All the amplifiers integrate Filtronic gallium arsenide (GaAs) high-electron-mobility transistor (HEMT) power amplifier (PA) monolithic microwave integrated circuits (MMICs), which are matched in performance and power-combined in waveguide to maximize power output. The 4- and 8-way models feature an integral temperature sensor with an analog output for accurate monitoring of thermal characteristics, along with the option of control circuitry for functions including gain control, mute control and alarms.



The Cerus amplifiers operate in the band 71–76GHz and 81–86GHz and offer what are claimed to be excellent saturated power output levels up to +36dBm or higher, and 1dB gain compression point at +31dBm. The transmit power control range is 10dB, and small-signal gain is typically 24dB.

With a typical output third-order intermodulation product (OIP3) of +39.5dBm at +29dBm output power, the high linearity of the amplifiers enables them to support 256QAM modulation for high-capacity transmission.

Measuring just 40mm x 40mm x 47mm and weighing only 160g, their low SWAP (size, weight and power) makes the amplifiers suitable for airborne and HAPS applications.

Input and output connection is via WR12 waveguide, and DC connection is via a multi-pin connector.

Wolfspeed opens Mohawk Valley 200mm SiC fab

New York-based fab expands capacity to meet steepening demand for SiC devices across automotive and industrial applications

Wolfspeed Inc of Durham, NC, USA – which makes silicon carbide materials as well as silicon carbide (SiC) and gallium nitride (GaN) power-switching & RF semiconductor devices — has officially opened its Mohawk Valley silicon carbide fabrication plant in Marcy, NY with a ribbon-cutting ceremony featuring Federal and State officials. The 200mm wafer fab will help to lead the industry-wide transition from silicon to silicon carbide-based semiconductors, says the firm.

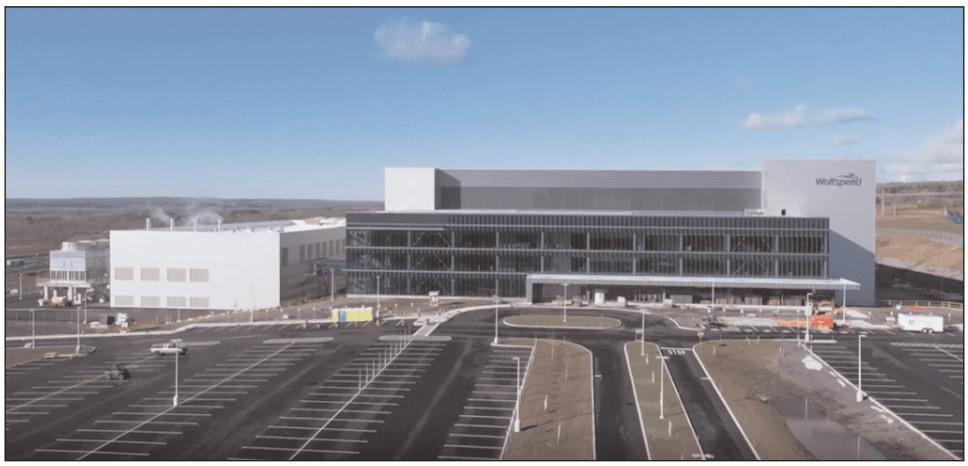
New York governor Kathy Hochul was on site to officially welcome Wolfspeed to Mohawk Valley, joined by Eric Bach, senior VP of product & chief engineer at automaker Lucid Motors, with whom Wolfspeed recently signed a multi-year agreement to supply silicon carbide devices. As a key partner, Lucid Motors had the honor of cutting the ribbon with its Lucid Air, named the 2022 MotorTrend Car of the Year. The Lucid Air Grand Touring features an official EPA-estimated 516 miles of range or 1050hp.

"We will be partnering with Wolfspeed to source the highest-quality silicon carbide components here in the State of New York, providing even more American jobs for the EV industry," says Bach.

"This fab will not only supply customers in 2022 but also support long-term American competitiveness," says Wolfspeed's president & CEO Gregg Lowe.

The automated Mohawk Valley facility is the world's first and largest 200mm silicon carbide fab. The devices developed there will be critical in feeding Wolfspeed's $20bn+ pipeline. The first silicon carbide lot was run at the facility earlier in April. More than 600 jobs should be created in Mohawk Valley by 2029.

Wolfspeed is also expanding its operations in North Carolina. with the creation of a materials factory in Durham, scheduled to be completed later this year. Together, these factories establish a national 'silicon carbide corridor' on the East Coast, combining Wolfspeed's 30+ year history of R&D in North Carolina with the technology base, manufacturing heritage, and talent in New York's Mohawk Valley.



Wolfspeed's new Mohawk Valley SiC fab in Marcy, NY.

"This site now holds incredible promise for our region, New York State, and especially our graduates who are well prepared for the types of leading-edge careers that will be available," comments Dr Tod A. Laursen, acting president of State University of New York Polytechnic Institute (SUNY Poly). "Our partnership with Wolfspeed is powering targeted, semiconductor-centered curricula and providing new high-tech equipment at SUNY Poly via the $250,000 Wolfspeed Curriculum Gift; uplifting traditionally underserved students through scholarship opportunities from Wolfspeed's $2,000,000 scholarship program over 10 years; and providing $1,500,000 in funding to establish the Dr John Edmond and Dr John Palmour SUNY Polytechnic Institute Endowed Faculty Chairs; all of which underpin the continued expansion of science, technology, engineering, and mathematics (STEM) opportunities for students at SUNY Poly," he adds.

"Twenty-seven months ago, Wolfspeed, State and Local partners announced plans by Wolfspeed to build the world's largest 200mm state-of-the-art silicon carbide semiconductor facility here in the Mohawk Valley," notes Mohawk Valley EDGE president & CEO Steven DiMeo. "We want to give special thanks to Gregg Lowe and the entire Wolfspeed team for their commitment and the tremendous community partner they have become with their financial commitments to SUNY Poly and Mohawk Valley Community College to produce the next generation of technology leaders."

'Ribbon-cutting' by Lucid Air Grand Touring electric car.

www.wolfspeed.com

Wolfspeed's silicon carbide power modules used in inverters of Lucid Air electric vehicle

Multi-year agreement for SiC devices from new Mohawk Valley Fab

Wolfspeed Inc of Durham, NC, USA – which makes silicon carbide materials as well as silicon carbide (SiC) and gallium nitride (GaN) power-switching & RF semiconductor devices — says that automaker Lucid Motors has deployed its silicon carbide power device solutions in its high-performance pure-electric car — the Lucid Air. Wolfspeed and Lucid have a multi-year agreement for Wolfspeed to produce and supply silicon carbide devices.

Lucid Air's inverters feature Wolfspeed's XM3 silicon carbide power modules. With low switching losses, minimal resistance and high power density, the XM3 power modules contribute to the efficiency and power density of Lucid's 163lb, 670hp (74kg 500kW) electric motor.

"Lucid's proprietary powertrain technology — engineered and produced in-house — is at the core of what makes Lucid Air the most advanced and most efficient luxury electric vehicle in the world," claims Eric Bach, senior VP of product & chief engineer at Lucid. "With the perfect blend of high performance and high efficiency, Wolfspeed's innovative silicon carbide MOSFET power semiconductors are an ideal fit for Lucid's advanced technology."

Wolfspeed's automotive-qualified 1200V silicon carbide XM3 half-bridge power module.

The Lucid Air will be supplied with Wolfspeed's silicon carbide semiconductors from its Mohawk Valley Fab in Marcy, NY. Opened on 25 April, the facility will be the world's largest 200mm SiC fabrication plant and dramatically expands production capacity for Wolfspeed's power devices. The partnership gives Lucid access to increased capacity to better support its long-term automotive production.

"Lucid Motors is an emerging leader in not only electric vehicles but the entire automotive industry," comments Wolfspeed's CEO Gregg Lowe. "As the world advances towards an all-electric future for transportation, silicon carbide technology is at the forefront of the industry's transition to EVs, enabling superior performance, range and charge time," he adds. "Our investment in the Mohawk Valley Fab ensures our customers, including Lucid, have access to the advanced products they need to deliver innovative solutions to the market."

www.lucidmotors.com

SemiQ launches 1200V 80mΩ SiC power MOSFET modules in SOT-227 packages

40mΩ and 20mΩ modules on the way

SemiQ of Lake Forest, CA, USA — which designs, develops and manufactures SiC components and 150mm SiC epiwafers for high-frequency, high-temperature and high-efficiency power semiconductor devices — has released its second-generation silicon carbide 1200V 80mΩ power MOSFET modules developed in industry-standard SOT-227 packages, namely the GCMS080B120S1-E1 with 1200V 10A parallel diode and the GCMX080B120S1-E1 without parallel diode. The 1200V silicon carbide MOSFET modules are the latest extension to the firm's SiC MOSFET product portfolio.

SemiQ's SiC MOSFETs bring high efficiency to high-performance applications including electric vehicles (EVs), power supplies and data centers, and are specifically designed and tested to operate reliably in extreme environments. The firm says that, compared with legacy silicon insulated-gate bipolar transistors (IGBTs), its MOSFETs switch faster with lower losses, enabling system-level benefits through reduced size, weight and cooling requirements.

"The SOT-227 package is one of the best fully isolated power semiconductors packages around," says president & general manager Michael Robinson. "Combined with our SiC MOSFETs and SiC diodes, these products are perfect for increasing efficiency in your fast charging and inverters systems," he adds.

Samples are in stock at SemiQ and available via distributors DigiKey, Mouser and Richardson Electronics. Also, 40mΩ and 20mΩ modules in the SOT-227 are on the way.

www.SemiQ.com

IRPS 'best paper' award for ST/CNR-IMM work on silicon carbide power devices

Correlation between MOSFET breakdown and 4H-SiC epitaxial defects

At the 2022 IEEE International Reliability Physics Symposium (IRPS) in Dallas, TX, USA (27-31 March), a team from STMicroelectronics and the Institute for Microelectronics and Microsystems at the National Research Council of Italy (Consiglio Nazionale delle Ricerche – Istituto per la Microelettronica e Microsistemi, CNR-IMM) in Catania, Italy, was recognized with the IRPS 2021 'best paper' award for 'Correlation between MOSFETs breakdown and 4H-SiC epitaxial defects', which exposed newly discovered relations between certain defects and the viability of silicon carbide (SiC) power devices.

Non-functioning 4H-SiC dies

The paper points to two types of defects: short-term and long-term. Among the first, the most severe is the t = 0 type, since it's non-functional from the start. For the first time, it is claimed, the paper exposes a direct relation between crystalline defects and failure rates in t = 0 4H-SiCs. Because of its physical characteristics, 4H-SiC offers better electron mobility than 6H-SiC (at 947cm2/Vs) but is easier to manufacture than 3C-SiC due to its atomic structure of four bilayers in a hexagonal lattice.

The team used atomic force microscopy (AFM) and cross-sections using scanning electron microscopes to look at t = 0. What they found is the presence of a crystalline precipitate at the bottom of the epitaxial layer that measures about 1.90µm in height. The authors' drive to understand why these devices were 'dead on arrival' led them to look deeper and discover a new relationship between crystalline precipitates and the rate of defects. The paper from ST and CNR-IMM received the award because it explored SiC dies in a new way.

Since publication of the paper, ST has learned to optimize the epitaxial reactor chamber and the manufacturing process for its 4H-SiC devices. It can hence improve yields and, therefore, make even more cost-effective and longer-lasting devices. In turn, it expects 4H-SiC power MOSFETs to penetrate even more markets and applications and thus help to increase energy efficiency.

Stress-testing the remaining 4H-SiC dies — what high-temperature gate bias stress tests revealed

After the researchers winnowed out the t = 0 dies, they put the functioning ones in a package and stress-tested them. The first challenge was a high-temperature gate bias stress, which upped the electric field at the gate oxide, in order to monitor behavior in normal and harsh conditions. It was noticed that some of the devices already exhibited abnormal behavior at 3MV/cm. To understand why this happened, the researchers examined the problematic dies under AFM, which revealed the presence of bumps on the gate oxide measuring between 20nm and 30nm.

The finding helped to sort devices that appeared to work correctly at first but suffered from defects that were nearly impossible to spot during production. Not only did the paper explain why the devices had anomalous gate conduction but it showed the importance of high-temperature gate bias testing. The results should thus help foundries looking to monitor their SiC devices' quality better.

What high-temperature reverse bias revealed

After the first stress tests, the dies underwent another trial: a high-temperature reverse bias. The benchmark lasted three months and served to simulate decades of normal use. It helped the authors to determine if all the devices would behave normally over their entire lifecycle. Also, while 98% of them did, the other 2% revealed abnormalities with gate currents seven times higher than normal. In a real-world application, such behavior would represent a severe malfunction. The challenge is that this 'silent killer' defect, while always there, would only manifest after years of normal use.

The authors first used a scanning electron microscope to understand what went wrong but could not perceive anything abnormal. As a result, they switched to transmission electron microscopy, which revealed the presence of a defect in the semiconductor under the gate's insulator. To further understand what it was, the authors used AFM, which enabled them to discover a triangular defect with a height of 18-30nm, depending on the stress test's duration. At this point, they understood that there was a threading dislocation from the substrate to the epitaxial layer. Consequently, they used scanning capacitance microscopy (SCM) to show the physical impact on the MOSFET device and explain its faulty electrical behavior.

It is only because the scientists used so many investigative technics that they were able to understand what happened, says ST. Put simply, the threading dislocation affects the valence band of the 4H-SiC device, effectively shrinking its bandgap. SiC's wide bandgap is responsible for the device's excellent electrical properties. Hence, anything responsible for shrinkage it will negatively impact the structure severely. In this instance, the valence band increased by about 0.8eV to 1eV, which is significant. Comparatively, SiC has a bandgap that varies between 2.3eV and 3.3eV, with 4H-SiC sitting at 3.23eV.

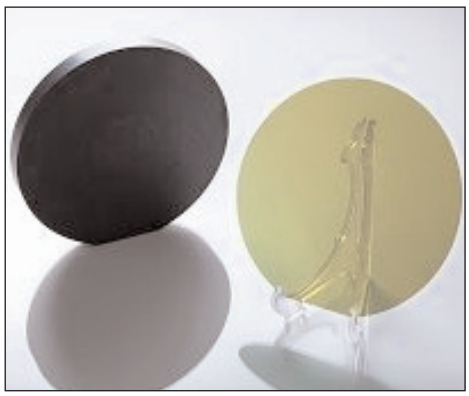
https://ieeexplore.ieee.org/document/9405148

Showa Denko enters mass production of 6-inch SiC single-crystal substrates

Epiwafer maker diversifying its sourcing of substrates by establishing in-house production

Tokyo-based wafer manufacturer Showa Denko K.K. (SDK) has launched the mass production of 6-inch (150mm)-diameter silicon carbide (SiC) single-crystal wafers, for processing into SiC epitaxial wafers for power semiconductor devices as demand rises rapidly in fields including electric vehicles (xEVs), railcars, and industrial equipment.

SDK has been considering in-house production of SiC substrates, aiming to improve the quality of its SiC epiwafers and to establish a stable supply chain for them. Between 2010 and 2015, SDK took part in the project 'Novel Semiconductor Power Electronics Project Realizing



Low Carbon Emission Society', which was coordinated initially by Japan's Ministry of Economy, Trade and Industry and then (from 2011) by the New Energy and Industrial Technology Development Organization (NEDO), as a member of the 'Research and Development Partnership for Future Power Electronics Technology'. Furthermore, in 2018, SDK took over the SiC-wafer-related assets of Nippon Steel & Sumitomo Metal Group (now Nippon Steel Group), and has since been developing technologies for the mass production of SiC wafers.

SDK says that it will continue purchasing SiC substrates from its partners so that it can respond to rapidly growing demand for SiC epiwafers for power semiconductors. The firm is hence diversifying its sourcing of SiC substrates, establishing a stable supply chain for SiC epiwafers.

www.sdk.co.jp

Infineon extends CoolSiC M1H technology portfolio with 1200V SiC MOSFETs

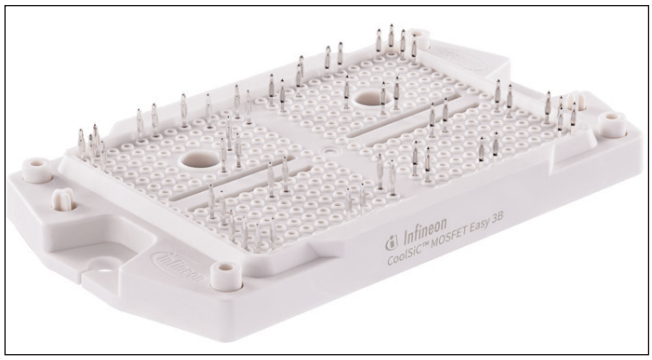
New 7mΩ, 14mΩ and 20mΩ on-resistances in TO247-3 and TO247-4 discrete packages, plus Easy modules with improved power density and system efficiency

Infineon Technologies AG of Munich, Germany has introduced a new CoolSiC technology: the CoolSiC MOSFET 1200V M1H. The silicon carbide (SiC) chip will be implemented in a widely extended portfolio using the Easy module family, along with discrete packages using .XT interconnect technology. The M1H chip offers high flexibility and is suitable for solar energy systems, such as inverters, that have to meet peak demand. The chip is also suitable for applications such as fast electric vehicle (EV) charging, energy storage systems and other industrial applications.

The latest advances of the CoolSiC base technology enable a significantly larger gate operation window that improves the on-resistance for a given die size. Simultaneously, the larger gate operation window provides a high robustness against driver- and layout-related voltage peaks at the gate, without any restrictions even at higher switching frequencies. Along with the M1H chip technology, related housings have also been adopted in technology and package variants to enable higher power densities and more options for design engineers to improve on application performance.

Easy modules enable higher power density

The M1H will be integrated into the Easy family to further improve the Easy 1B and 2B modules. In addition, a new product that enhances the Easy 3B module with the new 1200V CoolSiC MOSFET will also be launched. The roll-out of new chip sizes maximizes flexibility and ensures the broadest industrial portfolio. With the M1H chip, the on-resistance of the modules can be significantly improved, making the devices more reliable and efficient, says Infineon.



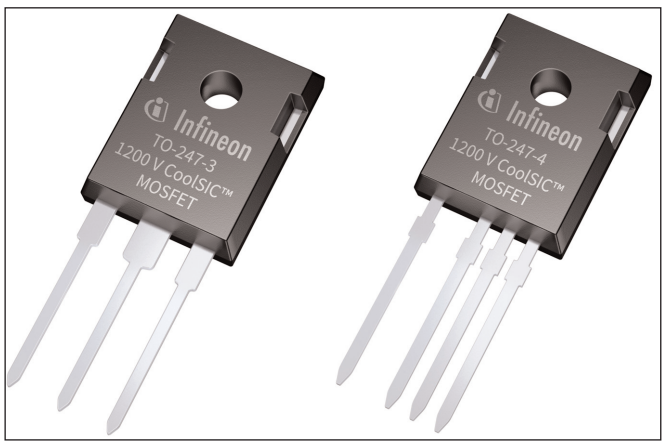
Infineon's CoolSiC M1H 1200V SiC MOSFETs will be integrated into the Easy family to further improve the Easy 1B and 2B modules. Also, a new product that enhances the Easy 3B module will be launched.

Furthermore, with a maximum temporary junction temperature of 175°C, overload capability increases, enabling higher power density and coverage of failure events. Compared with its predecessor (the M1), the M1H has implemented a small adoption of the internal RG, enabling the switching behavior to be easily optimized. The dynamic behavior is maintained with the M1H chip.

Discrete packages with ultra-low on-resistances

In addition to the Easy module family, the CoolSiC MOSFET 1200V M1H portfolio includes new ultra-low on-resistances 7mΩ, 14mΩ and 20mΩ in the TO247-3 and TO247-4 discrete packages. Infineon says that the new devices are easy to design-in, especially due to the gate voltage overshoots and undershoots with the new maximum gate–source voltage down to –10V, and come with avalanche and short-circuit capability specifications.

Infineon's .XT interconnection technology, previously introduced in the D2PAK-7L package, is now also implemented in a TO-footprint. The thermal dissipation capabilities are enhanced by more than 30% compared with a standard inter-connection. As a result, such thermal benefit can be used to increase the output power by up to 15%. Alternatively it can be used to increase the switching frequency to further reduce the passive components in, for example, EV charging, energy storage or photovoltaic systems for enhanced power density and reduced system cost. Without changing the system operating conditions, the .XT technology will lower the SiC MOSFET junction temperature, significantly increasing the system lifetime and power cycling capabilities (a key requirement in applications such as servo drives).



Infineon's CoolSiC MOSFET 1200V M1H portfolio includes TO247-3 and TO247-4 discrete packages with new ultra-low on-resistances of 7mΩ, 14mΩ and 20mΩ.

Both the module and the discrete variants are available to order now.

www.infineon.com/sic-mosfet

Fuji Electric
Innovating Energy Technology

Fuji Electric G-Twin UL Plug-In Series

New High Quality Product with improved safety features, easy installation and compact

TÜV Rheinland IEC JIS EN c UL us LISTED CE

Global Standard

The New Generation of Molded Case Circuit Breakers and Earth Leakage Circuit Breakers.

- ★ Built-In Compact Ground Fault for Space Saving Designs
- ★ Same Footprint! MCCBs and ELCBs interchangeable without Panel Modifications
- ★ All frame sizes (50AF-250AF) can be mounted with the same mounting pitch of 70mm
- ★ Lock Out Tag Out (LOTO) safety devices (fixed and removable types) are available as an option
- ★ Improves safety measures and easy & quick installation
- ★ UL489 and CSA C22.2 No.5 approved and certified

Fuji Electric Corp. of America **Distribution & Control Department**

For sales, product & distributor information, please visit americas.fujielectric.com/UL-Plug-In

or contact us: x-fea-fuji-dc@fujielectric.com

Penn State leading five-year, $7.5m study of radiation effects on wide-bandgap semiconductors

Research to better understand how radiation causes defect generation and evolution

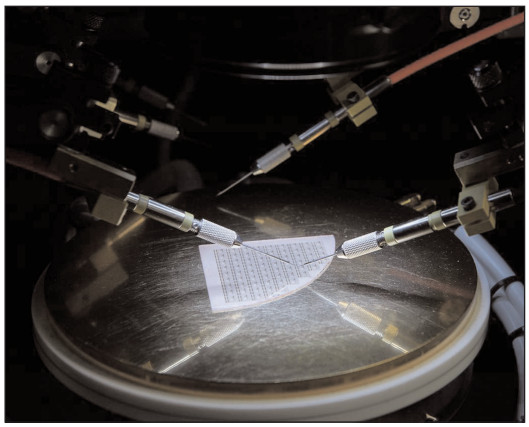
Compared with conventional silicon-based electronics, electronics using wide-bandgap semiconductors promise better resistance against radiation damage. So, in order to better predict and mitigate radiation-induced damage of wide-bandgap semiconductors, the US Department of Defense has awarded a five-year, $7.5m Defense Multidisciplinary University Research Initiative (MURI) Award to a new national collaboration led by Penn State University.

"Wide-bandgap semiconductors, such as gallium nitride, have shown advantages over silicon in radio frequency and power electronics," notes Rongming Chu, Thomas and Sheila Roell Early Career Associate Professor of Electrical Engineering, who is spearheading the project. "They are also inherently more resistant to radiation due to stronger atomic bonds."

This radiation hardness protects against damage caused by radiation from high-energy rays and particles, making wide-bandgap semiconductors promising candidates for building electronics used in environments with significant radiation (such as outer space), notes Chu. However, researchers have yet to reach the full potential of radiation hardness in wide-bandgap semiconductor electronics.

"Preliminary studies have indicated that the radiation resistance appears to be limited by defects in the semiconductors, rather than by the material's intrinsic properties," Chu says. "In this project, we seek to understand the radiation effects of these defects so that we may develop a strategy to redesign the wide-bandgap semiconductor device for the ultimate radiation hardness."

Examples of defects include unwanted impurities, displacement of atoms from their original sites and dangling atomic bonds at the interface between dissimilar materials. "There is a risk of these defects becoming electrically active under a high electric field, with energetic electrons, causing detrimental effects to device performance," Chu says. "Today's wide-bandgap semiconductor electronic devices are designed such that this risk is minimized under normal operating conditions. However, radiation can force the device out of its normal operating condition by exciting additional energetic electrons interacting with the pre-existing defects. It can also knock atoms out of their original positions, modifying pre-existing defects and generating new defects."



A transistor wafer undergoing testing on a probe station. Credit: Kate Myers/Penn State, Kelby Hochreither/Penn State.

To better understand how radiation causes defect generation and evolution, how these defects affect device operation and how to redesign future wide-bandgap devices for the optimum radiation hardness, an interdisciplinary team is critical, believes Chu. Collaborators include Patrick M. Lenahan, distinguished professor of engineering science and mechanics; Miaomiao Jin, assistant professor of nuclear engineering; and Blair R. Tuttle, associate professor of physics (all from Penn State); and Tania Roy, University of Central Florida; B. Reeja Jayan, Carnegie Mellon University, and Michael E. Flatté, University of Iowa. Chu notes that, at Penn State, the team will leverage the tools and experts affiliated with the Radiation Science and Engineering Center and the Nanofabrication and Materials Characterization User Facilities at the Materials Research Institute.

"The strength of our project comes from a combination of expertise: my research group's capabilities on gallium nitride devices, Dr Lenahan's expertise in defect spectroscopy, Dr Jin's radiation damage modeling, Dr Tuttle's defect theory work, Dr Roy's electrical characterization of radiation effects, Dr Jayan's defect structure characterization and Dr Flatté's transport theory work," Chu says. "The teamwork also extends beyond the investigators of this MURI project — especially Dr Michael Lanagan, professor of engineering science and mechanics, who was very instrumental in coordinating this multi-disciplinary team effort."

The grant will support 16 graduate students, including 11 at Penn State, to perform multi-disciplinary research encompassing physics, computation, materials science and engineering, and electrical engineering as they pursue a variety of master's degrees and doctorates.

"Not only will the research prepare next-generation technologists to take on technical challenges but, through our collaborative work with national laboratories and industry stakeholders, the students will also learn the professional skills needed to bridge fundamental research to real-world applications," Chu says.

www.mrsec.psu.edu

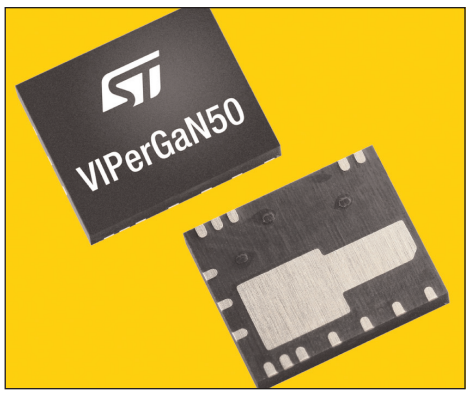
ST's 50W GaN converter enables high-efficiency power designs in consumer and industrial applications

Integrated 650V GaN power transistor allows high switching frequency with small, lightweight flyback transformer

STMicroelectronics of Geneva, Switzerland says that its VIPerGaN50 simplifies building single-switch flyback converters up to 50W and integrates a 650V gallium nitride (GaN) power transistor for superior energy efficiency and miniaturization.

With its single-switch topology and high integration, including current-sensing and protection circuitry also built-in, the VIPerGaN50 comes in a compact and low-cost 5mm x 6mm package. The speed of the integrated GaN transistor allows a high switching frequency with a small and lightweight flyback transformer. Minimal additional external components are needed to design an advanced, high-efficiency switched-mode power supply (SMPS).

The VIPerGaN50 helps designers to leverage GaN wide-bandgap technology to meet increasingly stringent eco-design codes that target global energy savings and net-zero carbon emissions. It is suited to consumer and industrial applications such as power adapters, USB-PD chargers, and power supplies for home appliances, air conditioners, LED lighting equipment, and smart meters.



The converter operates in multiple modes to maximize efficiency at all line and load conditions. At heavy load, quasi-resonant (QR) operation with zero-voltage switching minimizes turn-on losses and electromagnetic emissions (EMI). At reduced load, valley skipping limits switching losses and leverages ST's proprietary valley lock to prevent audible noise. Frequency foldback with zero-voltage switching ensures the highest possible efficiency at light load, with adaptive burst mode operation to minimize losses at very low load. In addition, advanced power management cuts standby power to below 30mW.

Built-in features ensure safety and reliability, including output over-voltage protection, brown-in and brown-out protection, and input over-voltage protection. Input-voltage feedforward compensation is also provided, to minimize output peak-power variation, as well as embedded thermal shutdown, and frequency jittering to minimize EMI.

The VIPerGaN50 is in production now and available in a 5mm x 6mm QFN package, from $2.30 for orders of 1000 pieces. The device is in a free-sample program and can be ordered on ST eSTore.

www.st.com/vipergan

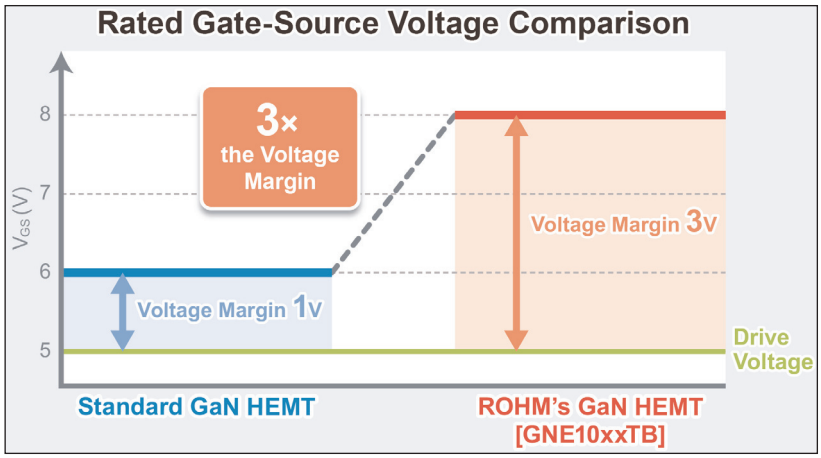
ROHM starts production of 150V GaN HEMTs with 8V gate–source voltage

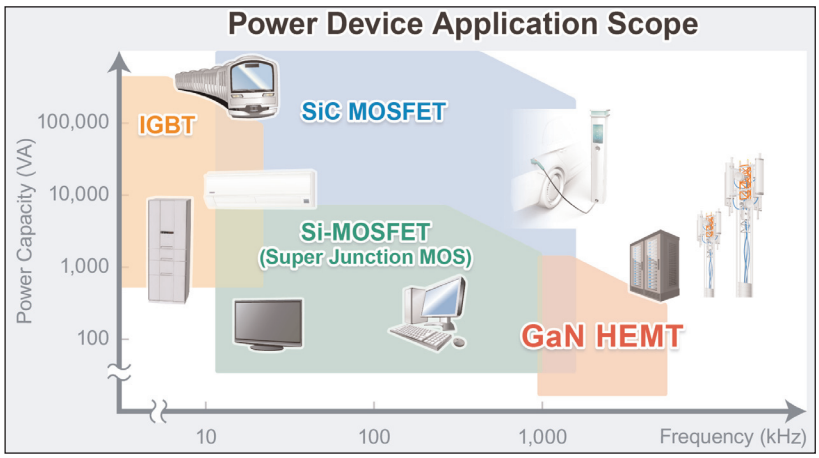
Power semiconductor maker ROHM says that its new GNE10xxTB series of 150V gallium nitride (GaN) high-electron-mobility transistors (HEMTs) increases the gate withstand voltage (rated gate-source voltage) to what is claimed to be an industry-leading 8V — ideally to be applied in power supply circuits for industrial equipment such as base stations and data centers along with Internet of Things (IoT) communication devices.

In recent years — due to the rising demand for server systems in response to the growing number of IoT devices — improving power conversion efficiency and reducing size have become important issues requiring further advances in the power device sector, notes ROHM. As GaN devices generally provide higher switching characteristics and lower ON-resistance than silicon devices, they are expected to contribute to lower power consumption of various power supplies and greater miniaturization of peripheral components.

Along with mass-producing silicon carbide (SiC) devices and feature-rich silicon devices, ROHM says that it has developed GaN devices that achieve superior high-frequency operation in the medium-voltage range, allowing it to provide power solutions for a wider variety of applications.

These new products utilize an original structure that raises the rated gate–source voltage from the conventional 6V to 8V. As a result, degradation is prevented, even if overshoot voltages exceeding 6V occur during switching — contributing to improved design margin and higher reliability in power supply circuits. The GNE10xxTB series is offered in a versatile DFN5060 (5.0mm x 6.0mm x 1.0mm) package featuring what is claimed to be superior heat dissipation and large current capability, facilitating handling during the mounting process.





Under the name EcoGaN, ROHM has trademarked GaN devices that contribute to greater energy conservation and miniaturization by maximizing the low ON-resistance and high-speed switching characteristics of GaN, with the goal of reducing application power consumption, miniaturizing peripheral components and reducing design load along with the number of parts required. Starting with the GNE1040TB with a drain–source ON-resistance of 40mΩ, the firm is working to expand the EcoGaN lineup with devices that improve performance. Application examples are cited as: 48V input buck converter circuits for data centers and base stations; boost converter circuits for the power amplifier block of base stations; Class D audio amplifiers; and light detection & ranging (LiDAR) drive circuits and wireless charging circuits for portable devices.

Going forward, ROHM will continue to develop control ICs that leverage analog power supply technology such as Nano Pulse Control and modules that incorporate these ICs, along with power solutions that contribute to a sustainability by maximizing the performance of GaN devices.

Japan's Ministry of Economy, Trade and Industry (METI) has set a target of 30% energy savings for new data centers by 2030. However, system performance must not only be energy efficient but also robust and stable, as data centers have become a vital part of social infrastructure, says ROHM.

In response, ROHM's new GaN device with a gate withstand voltage of 8V provides a high degree of robustness and stability while achieving what is claimed to be superior energy savings. The firm says that, beginning with these products, it will continue to improve power supply efficiency in power sources by combining with proprietary Nano Pulse Control analog power supply technology, creating a technical trend that will help the semiconductor and telecoms industries become carbon neutral by 2040.

www.rohm.com

ROHM and Delta partner on developing and mass producing GaN devices

600V-breakdown GaN power devices to be optimized for power supply systems

Japan-based power semiconductor maker ROHM Co Ltd and power supply maker Delta Electronics Inc have entered into a strategic partnership to develop and mass produce gallium nitride (GaN) power devices.

Combining Delta's power supply device development technology with ROHM's market-proven power development and manufacturing expertise will make it possible to develop 600V breakdown voltage GaN power devices optimized for a wide range of power supply systems.

ROHM has already (in March) established a mass-production system for 150V GaN high-electron-mobility transistors (HEMTs) featuring what is claimed to be a breakthrough 8V gate withstand voltage. This will allow the firm to expand its new EcoGaN device range for power circuits in Internet of Things (IoT) communications and industrial equipment (i.e. base stations, data centers) while further improving device performance (maximizing the low-ON-resistance and high-speed-switching characteristics of GaN to achieve lower application power consumption, smaller peripheral components, and simpler designs that require fewer parts).

"As power semiconductors – a key area of focus for ROHM – play an increasingly important role in achieving a decarbonized society, ROHM will continue to develop advanced devices in a range of fields utilizing silicon, silicon carbide (SiC) and GaN, along with solutions that combine peripheral components such as control ICs that maximize their performance," says Kazuhide Ino, ROHM's managing executive officer & chief scientific officer (CSO). "Through this partnership, ROHM will mass produce GaN power devices that can contribute to the configuration of more efficient power supply systems as well as develop GaN IPMs [intelligent power modules] that integrate analog ICs (one of ROHM's strengths) at an early stage, further expanding our lineup of easy-to-use products," he adds.

"The development of GaN power devices is of significant interest to the global electronics industry," notes Mark Ko, vice chairman, Delta Electronics. "We have been working with ROHM for many years, and are very pleased that this year's technical exchange will finally produce results, which is a milestone for both companies and one that will bring us closer together," he adds. "In addition to this GaN collaboration, Delta is looking to further strengthen its product lineup as a key business strategy, with high expectations for product development utilizing ROHM's strengths in analog (Nano) and other technologies. We believe that strengthening our collaboration with ROHM will allow us to provide a wide range of solutions that meet the needs of the global power supply market."

Improving the efficiency of motors and power supplies (which are said to account for the most of the world's electricity consumption) has become a significant hurdle to achieving a decarbonized society. As power devices hold the key to improving efficiency, the adoption of new materials such as SiC and GaN is expected to further increase the efficiency of power supplies. ROHM and Delta says they have been engaged in technology exchanges and building a cooperative relationship for the development of various applications over many years and, through this partnership, both companies aim to develop and mass produce GaN power devices that maximize GaN performance to accelerate power technology innovation.

www.deltaww.com
www.rohm.com

Nexperia demonstrating power semiconductor developments at PCIM

New surface-mount copper-clip package for power GaN FETs on show

In booth #317 (Hall 9) at Power, Control and Intelligent Motion (PCIM) Europe 2022 in Nürnberg Messe, Nuremberg, Germany (10–12 May), Nexperia B.V. of Nijmegen, the Netherlands (a subsidiary of Wingtech Technology Co Ltd) is demonstrating the latest innovations and developments in power semiconductors across a wide range of applications including the following:

Wide-bandgap

• CCPAK: Nexperia's new surface-mount copper-clip package for power gallium nitride (GaN) FETs;
• Nexperia's evaluation board for benchmarking dynamic performance of 650V silicon carbide (SiC) rectifiers;
• Broadcom half-bridge evaluation board using Nexperia's CCPAK GaN FETs and Nexperia totem pole power factor correction (PFC) demo containing TO-247 GaN FETs.

Power management

• LFPAK88 MOSFETs for 12V high-current circuit protection applications live demo;
• Power bipolar transistors in high-voltage LED lighting application;
• Clip-bonded FlatPower (CFP) package replacing SMx demo.

Motor control

• 500A high-current MOSFETs live demonstration;
• LFPAK MOSFETs increasing to highest current in BLDC motor control demo;
• 50/55V application-specific MOSFETs (ASFETs) — 'the big pull'.

Next-generation support tools for power design engineers

• Precision Electrothermal models for MOSFETs enabling early design validation;
• Interactive Application Notes and MOSFET and GaN FET Application Handbook;
• Evaluation boards for power products.

Also, at PCIM 2022 Nexperia is showing how LFPAK MOSFETs are used in a surfboard e-fin and deliver a number of live technology talks on MOSFETs, GaN FETs and component technology for vehicle electrification.

"After more than two years being forced to attend events virtually, the team at Nexperia is excited to once again be able to reconnect with valued customers in-person at PCIM 2022," according to Chris Boyce, senior director marketing & product group head of Nexperia's Power MOSFETs business group. "Digital collaboration tools have their place, but nothing can replace the type of interpersonal connection that happens at industry events, and which so often acts as a catalyst for new and innovative designs ideas".

www.mesago.de/en/PCIM/main.htm
www.nexperia.com

NXP launches RF GaN power transistors for 32T32R active antenna systems

Smaller, lighter massive MIMO 5G radios ease deployment in urban and suburban areas

NXP Semiconductors N.V. of Eindhoven, The Netherlands has announced a new series of RF power discrete solutions for 32T32R active antenna systems, using its latest proprietary gallium nitride (GaN) technology. The new series complements NXP's existing portfolio of discrete GaN power amplifier solutions for 64T64R radios, covering all cellular frequency bands from 2.3GHz to 4.0GHz. NXP now offers what is claimed to be the largest RF GaN portfolio for massive multiple input, multiple output (massive MIMO) 5G radios.

As 5G networks continue to expand around the world, mobile network operators are adding 32T32R radios to increase their massive MIMO coverage beyond ultra-dense urban areas into less dense urban and suburban areas. By combining 32 antennas instead of 64, coverage can be maintained more cost effectively, while maintaining high-end 5G enabled by massive MIMO.

NXP says that its 32T32R solutions deliver twice the power in the same package as its 64T64R solutions, resulting in a smaller and lighter overall 5G connectivity solution. This pin-compatibility enables network operators to scale rapidly across frequency and power levels.

"As 5G deployments continue to expand globally, network operators need to extend their coverage while maintaining performance," notes Jim Norling, VP & general manager, High Power Solutions, Radio Power, at NXP. "By offering twice the power in the same package size, NXP enables RF engineers to create base stations that are smaller, lighter and easier to deploy and conceal in urban and suburban areas."

The new series of GaN discrete solutions is designed for 10W average power at the antenna, targeting 320W radio units, with up to 58% of drain efficiency. It includes driver and final-stage transistors and leverages NXP's highly linearizable RF GaN technology manufactured in the firm's new GaN fab in Arizona.

www.nxp.com/DMSPRODUCTS

Power Integrations unveils quasi-resonant power factor correction IC with 750V GaN switch

HiperPFS-5 ICs enable compact, efficient power-factor stage for ultra-fast adapters, consumer electronics, computer & appliance power supplies

Power Integrations has launched the HiperPFS-5 family of power-factor correction (PFC) ICs, which have an integrated 750V PowiGaN gallium nitride switch. With efficiency of up to 98.3%, the new ICs deliver up to 240W without a heat sink and can achieve a power factor of better than 0.98. HiperPFS-5 ICs are suitable for high-power USB PD adapters, TVs, game consoles, all-in-one computers and appliances.

"With OEMs and after-market suppliers racing to create the fastest, smallest, most versatile USB PD chargers for mobile devices, HiperPFS-5 ICs give engineers a critical advantage," claims senior product marketing manager Edward Ong. "We have combined our proprietary PowiGaN switch with a quasi-resonant, variable-frequency discontinuous mode boost PFC topology. By pairing HiperPFS-5 ICs with our new HiperLCS2 chipset or our InnoSwitch4-CZ active-clamp flyback ICs, designers can easily beat even the most aggressive efficiency regulations while cutting the bill of materials by half and achieving extremely attractive form factors for ultra-fast chargers."

The capacitors and inductors used in power supplies generate a phase change between current and voltage, causing losses in the power lines and potentially disrupting other equipment connected to the AC mains. Many countries need power supplies over 75W to adjust for this effect by using power-factor correction. Many PFC solutions are available, but HiperPFS-5 ICs with PowiGaN technology and a quasi-resonant (QR) control scheme provide off-line power quality enhancement.

HiperPFS-5's QR discontinuous conduction mode (DCM) control technique adjusts the switching frequency across output load, input line voltage and input line cycle. QR DCM control ensures low switching losses and permits the use of a low-cost boost diode. The variable frequency engine allows the reduction of boost inductor size by more than 50% compared with conventional critical-conduction-mode (CRM) boost PFC circuits. Low switching and conduction losses — which are further reinforced by the PowiGaN switch — together with lossless current sensing, mean that HiperPFS-5 ICs offer high efficiency across the entire load range, with efficiency rising as high as 98.3%. HiperPFS-5 ICs provide a PF higher than 0.98 at full load. At light loads a power-factor enhancement (PFE) feature compensates for input filter capacitance, maintaining a high PF of 0.96 even at 20% load. No-load power consumption is just 38mW.

Other benefits accrue due to the robust 750V PowiGaN switch. In many locations worldwide the mains power can be highly unstable, often leading to over-voltage failure of power supply components. HiperPFS-5 ICs maintain a high power factor up to $305V_{AC}$ and can operate continuously at up to $460V_{AC}$ during line swells. Additionally, HiperPFS-5 ICs incorporate Power Integrations' automatic X-capacitor discharge (CAPZero) function, including the required redundant pins to meet safety regulations, and high-voltage self-start-up — all in a low-profile InSOP-T28F SMD power package. Exposed cooling pads featured in the package are at source potential, providing effective cooling and simplifying the EMI solution. Digital line-peak-voltage detection ensures robust performance, even in the presence of distorted input from uninterruptable power supplies (UPS) or generators.

Reference design DER-672 is available to download for designers wishing to evaluate the HiperPFS-5 quasi-resonant PFC controller ICs. Devices are priced at $2.34 in 10,000-unit quantities.

www.power.com

New automotive and high-power products at PCIM

At Power, Control and Intelligent Motion (PCIM) Europe 2022 in Nuremberg, Germany (10–12 May), Power Integrations Inc of San Jose, CA, USA, which provides high-voltage integrated circuits for energy-efficient power conversion, is showcasing new products for the electric vehicle (EV) and industrial gate driver markets in booth 318 (Hall 9).

The firm's products are also being featured in the booths of partner Infineon Technologies (Hall 7, booth 412), Hitachi Europe Ltd (Hall 9, booth 354), Hy-Line (Hall 9, booth 433) and MEV Elektronik Service (Hall 7, booth 440).

In addition, Power Integrations is participating in the following panel and speaking sessions:

- 11 May (2:15–3:15pm) in booth 6-246 (Hall 6): president & CEO Balu Balakrishnan, 'The Next Level of Wide Bandgap Design — GaN' panel session;
- 12 May (2:25–2:45pm) in booth 6-224 (Hall 6): senior director & automotive systems engineer Michael Hornkamp, 'ASIL-Ready 1200 V Gate-Drivers for Electric Buses & Trucks' presentation.

www.mesago.de/en/PCIM/main.htm

Navitas joins PowerAmerica consortium

Firm to aid upgrade of power semiconductors beyond legacy silicon

GaN power integrated circuit firm Navitas Semiconductor of El Segundo, CA, USA and Dublin, Ireland has announced its membership of PowerAmerica, a public–private research initiative established in 2014 between industry, government, national labs and academia dedicated to accelerating the adoption of wide-bandgap (WBG) silicon carbide (SiC) and gallium nitride (GaN) power electronics.

Navitas says that, as a member of PowerAmerica, it will provide input into initiatives to help companies that use power semiconductors to upgrade beyond legacy silicon, and access resources and relationships contributing to business growth.

GaN runs up to 20x faster than legacy silicon and enables up to 3x more power, 40% energy savings and 3x faster charging in half the size and weight. Navitas' GaNFast power ICs integrate GaN power and drive plus sensing, protection and control circuits to deliver simple, small, fast and efficient power conversion performance for mobile, consumer, enterprise, eMobility and new energy markets. Over 145 Navitas patents are issued or pending.

With adoption by customers including Samsung, Dell, Xiaomi, Lenovo and LG, the firm's technology is now available with a 20-year limited warranty, which is reckoned to be a critical accelerator for GaN's adoption into higher-power data-center, solar and electric vehicle (EV) markets.

"The upgrade from legacy silicon to WBG semiconductors is critical to supporting environmental goals by dramatically reducing power consumption and accelerating the adoption of sustainable technologies," says Navitas' chief operating officer/chief technology officer & co-founder Dan Kinzer. "The consortium's membership network of entrepreneurs, technologists and academic partners is helping to drive this revolution and we are excited to be part of this increasingly important eco-system."

Navitas' senior director of marketing, Llew Vaughan-Edmunds, is currently the chairman of PowerAmerica and will lead the MAC meeting during the PowerAmerica 2022 Summer Workshop on NC State Campus in Raleigh, NC on 2 August. At the workshop, Navitas will host a technology seminar to introduce GaNFast power ICs with GaNSense technology, and stress high-quality, high-capacity manufacturing, with over 40 million units shipped and zero reported GaN-related field failures.

"With its proven integrated GaN technology and its focus on applications that range from consumer electronics through electric vehicles to data centers and solar power, Navitas brings important technology and solutions knowledge to the PowerAmerica eco-system," comment PowerAmerica's executive director & chief technology officer professor Victor Veliadis.

www.poweramericainstitute.org

GaN IC drives vivo's first 8"-screen foldable smartphone

Navitas Semiconductor says its next-generation GaNFast power ICs with GaNSense technology have been selected to power vivo's first folding-screen flagship 'X Fold' in-box 80W flash charger.

The vivo X Fold adopts a high-capacity 4600mAhr dual-battery solution charging 0-50% in just 17 minutes, and fully charged to 100% in only 37 minutes. The X Fold features multiple technological innovations, with Qualcomm Snapdragon 8+, 120Hz refresh rate, 3D ultrasonic dual-screen fingerprint access, and the world's first 300,000-fold TUV reliability certification.

As the first in-box GaN charger for a foldable phone, the dual-output 80W USB-C charger supports vivo's proprietary fast-charge protocol and industry-standard USB-PD, with simultaneous fast charging of two devices. The new 80W, folding-pin, in-box charger measures only 60mm x 41mm x 31mm (76cc), achieving a power density of over 1W/cc and a lightweight 125g. The full 80W power rating is shared over the two output ports to allow flexible, simultaneous charging of phones, tablets, audio and ultra-book laptops.

The latest generation of GaNFast ICs with GaNSense technology integrates real-time, accurate and fast sensing of system parameters, including current and temperature, and achieves patent-pending, loss-less current-sensing to deliver an additional 10% energy savings. GaNSense is said to enables a 'detect-to-protect' time of only 30ns — 6x faster than discrete GaN power chips for increased system reliability.

For the X Fold's 80W fast charger, Navitas' NV6136A GaNFast power IC with GaNSense technology is used in a high-frequency, quasi-resonant (HFQR) topology for optimal system price and performance.

"Using Navitas GaN technology, this charger will bring consumers a breakthrough dual-port, faster and lighter charging experience," says vivo's product line general manager Hong Yi.

"As every GaN IC shipped saves 4kg of CO_2, together we will achieve a faster, lighter, more efficient and more environmentally friendly charging future," says Navitas' CEO & co-founder Gene Sheridan.

www.navitassemi.com

Navitas CEO giving plenary talk at CS MANTECH

GaN power integrated circuit firm Navitas Semiconductor of El Segundo, CA, USA and Dublin, Ireland says that CEO & co-founder Gene Sheridan is a plenary speaker at the 36th International Conference on Compound Semiconductor Manufacturing Technology (CS MANTECH 2022) in Monterey, CA, USA (9–12 May), which brings together around 450 participants from different sectors of the semiconductor supply chain and comprises technical papers, talks, workshops, 'fireside chats' and manufacturer exhibits.

Sheridan's in-person plenary presentation 'GaN's expected Impact on the Power Electronics Industry to Electrify Our World' (at 9.15am PDT on 10 May) looks at how wide-bandgap (WBG) technologies are set to displace a significant portion of silicon power devices over the next decade and considers the significant market opportunities, challenges and impacts for GaN to participate in and accelerate the transition from fossil fuels to electrical energy.

"The event is the perfect opportunity to highlight how next-generation WBG power technologies, such as GaN and silicon carbide (SiC), will play an essential role across all major segments to significantly improve energy efficiency, reduce global CO_2 emissions, and achieve our global environmental sustainability goals to 'Electrify our World'," says Sheridan.

"Members of the compound semiconductor manufacturing community are increasingly working with next-generation, wide-bandgap materials and are keen to find out more about the role of GaN in the ecosystem," notes Martin Kuball, chairman of the 2022 CS MANTECH Technical Program. "This presentation will give the community insight into the opportunities that lie ahead for widespread GaN adoption."

GaN runs up to 20x faster than legacy silicon and enables up to 3x more power, 40% energy savings and 3x faster charging in half the size and weight. Navitas' GaNFast power ICs integrate GaN power and drive plus protection and control circuits to deliver simple, small, fast and efficient power conversion performance for mobile, consumer, enterprise, eMobility and new energy markets. Over 140 Navitas patents are issued or pending. The latest generation of GaNFast ICs with GaNSense technology integrates critical, real-time, autonomous sensing and protection circuits that further improves Navitas' reliability and robustness.

Due to advanced material performance and Navitas' proprietary AllGaN process design kit, GaN power ICs are much smaller than silicon chips, and have 4–10x lower CO_2 footprint to manufacture and ship. Also, due to their superior level of performance, higher system efficiencies can be achieved to significantly reduce wasted electrical energy and CO_2 emissions. In data centers, GaN has the potential to save over 10 million tons of CO_2/year through increased efficiency. For electric vehicles (EV), it is estimated that an upgrade from silicon to GaN in on-board chargers (OBCs), DC–DC converters and traction drive inverters could accelerate the worldwide transition from internal combustion engines to EVs by three years, and reduce total road-sector emissions by 20% per year.

With over 40 million devices shipped and no GaN-related field failures, Navitas says that its GaN is proven in the high-end fast charger market. This technology is now available with a 20-year warranty — a critical accelerator for GaN's adoption in data-center, industrial automation, solar and EV markets.

www.csmantech.org
www.navitassemi.com

GaN ICs for high-power markets highlighted at PCIM

20-year warranty extending into data centers, solar and EV markets

In booth 523 (Hall 9) at Power, Control and Intelligent Motion (PCIM) Europe 2022 in Nürnberg Messe, Nuremberg, Germany (10–12 May), Navitas Semiconductor is highlighting next-generation IC technologies and market advancement.

Navitas says that its recent announcements of 40 million mass-production shipments with zero reported GaN-related field failures and an industry-benchmark 20-year limited warranty have confirmed the quality and reliability of its GaNFast ICs across multiple markets and applications with customers including Samsung, Xiaomi, Dell, Lenovo and LG. Application-specific GaN ICs tailored for data center, solar and electric vehicles (EVs) were sampled in late 2021, and PCIM provides an opportunity to update customers on efficiency, power density, quality and reliability for these new, higher-power markets.

"Europe is a key market for Navitas, which is reflected in our growing team presence, our industry-leading focus on sustainability, and the development of multiple GaN IC families targeting 1–20kW applications," says CEO & co-founder Gene Sheridan. "With recent customer announcements from Brusa (EV), Enphase (solar) and especially Compuware (data center) with the looming EU 'Titanium+' Directive 2009/125/EC, plus application-specific design centers, we can demonstrate Navitas' rapid progress into these strategic, higher-power markets."

www.mesago.de/en/PCIM/main.htm

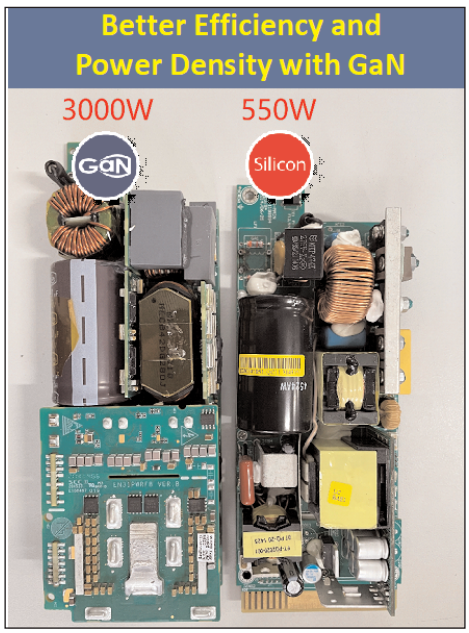
GaN Systems and GSR conducting Internet data center power supply field trial

Beta test at Northwest University shows energy efficiency up to 98% at 50% load

GaN Systems Inc of Ottawa, Ontario, Canada (a fabless developer of gallium nitride-based power switching semiconductors for power conversion and control applications) and Xuzhou GSR Semiconductor Co Ltd have jointly announced what is claimed to be the first industry field trial of GaN in the power infrastructure of an Internet data center (IDC), reckoned to be a key milestone toward the universal adoption of GaN in IDCs.

Offering higher power density with exceptional reliability, GaN Systems reckons that its technology can enable up to 20% energy savings for a data center compared to the use of legacy silicon power semiconductors. These energy savings increase profit margins, lower energy consumption, and reduce the data-center carbon footprint. The field trial is a critical step toward global adoption of GaN in IDCs, as it confirms the magnitude of energy savings for positive environmental impact while meeting the rigid reliability requirements of data-center operators, says GaN Systems.

Industry insiders have high expectations and are paying close attention to progress in adopting GaN in data-center power supply systems, says the firm. According to the China Institute of Communications (CIC), in 2020 data-center power consumption in China exceeded 200 billion kWh (about 2% of China's total power consumption), accounting for a power usage effectiveness (PUE) of 1.49 and carbon dioxide emission of 135 million tons and a carbon intensity (CUE) of 0.82 (about 1.14% of national carbon dioxide emissions). The '14th Five Year Plan for Digital Economy Development' requires Chinese companies to comply with the principles of low-carbon and energy efficiency,



3000W GaN power supply versus 550W silicon power supply (Xuzhou GSR Semiconductor Co Ltd).

continuously promote green construction, accelerate energy savings, and improve the utilization of renewable energy in data centers. It is critical for data centers to improve energy efficiency as China aims to achieve carbon neutrality. The adoption of new technology for energy efficiency and carbon reduction in data centers should not only promote green development for data centers but also help China to reach carbon neutrality by 2060, it is expected.

"Our company has dedicated years of effort to develop fast-charging devices for electric vehicles, solar inverters and IDC power supplies around the world," says GaN Systems' CEO Jim Witham. "GaN Systems is thrilled to partner with GSR Semiconductors and other leading customers, such as Great Wall and the Chinese Academy of Sciences, to leverage our highly efficient and high-reliability GaN semiconductors to support China's goal to reach carbon neutrality by 2060," he adds.

"Up to 20% energy savings for data centers is a disruptive technological innovation, thanks to the adoption of the latest GaN semiconductor technology," comments GSR Semiconductors' chairman Sonny Wu. "We expect more Chinese technology companies like Xuzhou GSR Semiconductor to build a local supply chain for high-end GaN chips for EV and IDC applications."

The beta test was first launched in March at the High Performance Computing Centre of the Physics Department at Northwest University (NWU-HPC) in the USA. More data centers will be selected for trials going forward.

The power supplies for this trial (which has received support from Shenzhen Frontier Lab, a unit of HG Semiconductors) were designed in Beijing and leveraged technology from GaN Systems and GSR Semiconductor. Analysis indicates that the energy efficiency of the new power supply at 50% load is up to 98% (4% higher than that of traditional silicon-based power supplies). This alone can reduce total energy consumption of the data center by 10%. When combined with the replacement of UPS power supplies and cooling systems in data centers, the energy reduction is expected to reach up to 20%.

According to the recently released plan of the national computing power network, China has eight national hub nodes and ten large data-center clusters. The use of GaN power transistors for more energy-efficient PSU power modules can offer a foundation for the development of energy-efficient data centers, hence supporting China's target of carbon neutrality by 2060.

www.gan-systems.com

GaN Systems exhibiting at PCIM Europe 2022

Products span data center, industrial, automotive & hi-rel applications

At Power, Control and Intelligent Motion (PCIM) Europe 2022 in Nuremberg, Germany (10–12 May), GaN Systems Inc of Ottawa, Ontario, Canada (a fabless developer of gallium nitride-based power switching semiconductors for power conversion and control applications) is showcasing solutions that, it says, unlock the value of smaller, lighter and lower-cost power electronics and enable companies to create more energy-efficient power electronics requiring fewer scarce resources and materials.

In booth #509 (Hall 9) the firm is exhibiting products across its major business units, including data center, industrial, automotive and high-reliability (hi-rel).

Data Center

Power supplies developed with GaN Systems transistors have double the power density of legacy power supply units (PSUs) and enable up to 20% energy savings in data centers. Products on display include SoluM's high-power-density 2700W power supply, which achieves performance with Titanium efficiency, 82W/in^3 power density and a small form factor of 185mm in length (versus the 265mm of legacy products). Also on display is Compuware's 3kW PSU, which achieves a 50% power increase compared with its prior 2kW PSU in the same form factor. GaN Systems is displaying its 3kW BTP-PFC and 3kW LLC Converter evaluation kits, which help customers get to market faster and exceeds the 80 PLUS Titanium efficiency requirements when combined in a design.

New technical solutions from GaN Systems include an array of thermal management solutions that reduce thermal resistance by up to 90%.

Industrial

Factory and industrial motors, street and commercial lighting, and transportation are the most significant energy users and contributors to pollution. Increased energy efficiencies and cost-saving opportunities are needed in motor drive, lighting and electrification to improve our environmental footprint. On display is Signify's Philips LED bulb with a built-in GaN Systems-based driver that results in a lower-cost, higher-power and more energy-efficient LED lighting solution and Siemens GaN-based drive in its Simatic Micro-Drive product line, which offers increased efficiency and faster motor response time. Additionally, several E-mobility DC–DC and inverter customer products will be on display that demonstrate the benefits of GaN for e-bikes, e-scooters, and more.

Automotive

GaN Systems has demonstrated its role in automotive with the commercialization of its AutoQual+-qualified transistors and investments from BMW, Toyota, Vitesco Technologies, and USI. GaN is being designed into on-board charger, traction inverter, and DC-to-DC converter applications. GaN Systems' exhibit includes the on-board chargers (OBCs) of Canoo, whose lifestyle delivery, base, and premium vans will be released in 2022. Additionally, the All-GaN Vehicle traction inverter and BrightLoop's DC/DC converter product for electric motorsport is being showcased. Furthermore, an array of high-power GaN module designs is on display that features the latest packaging technologies.

High-Reliability

Aerospace, avionics, space and some industrial and scientific applications have unique requirements for system designers where failure-free operation and long lifetimes in harsh mechanical, thermal and radiation conditions are absolute. In partnership with Teledyne HiRel Electronics, GaN power transistors deliver the efficiency, size and power-density benefits required for demanding HiRel power applications, says GaN Systems. These include propulsion systems that meet challenges in high-power, high-density motors or aerospace power and energy storage for power conversion and control, distribution and transmission. Most recently, Teledyne with GaN Systems released their new 650V, 60A GaN high-electron-mobility transistors (HEMTs), which have been tested through NASA's stringent Level 1 screening flow and can be qualified to NASA's full Level 1 conformance per customer requirements.

"The shift and massive adoption of GaN power transistors are ushering in product innovation in power electronics unlike ever before," says Paul Wiener, VP of strategic marketing at GaN Systems. "We're excited to be back at PCIM and show the innovation happening across automotive, data center, industrial and many other markets with our customers' GaN-based solutions."

www.mesago.de/en/PCIM/main.htm
www.gansystems.com

Transphorm demonstrating 99% efficiency power switching with 1200V GaN power transistor

High-voltage device extends gallium nitride's reach to high-power electric vehicle and renewable applications

At the International Symposium on Power Semiconductor Devices and ICs (ISPSD 2022) in Vancouver, Canada (22–26 May), Transphorm Inc of Goleta, near Santa Barbara, CA, USA — which designs and manufactures JEDEC- and AEC-Q101-qualified gallium nitride (GaN) field-effect transistors (FETs) for high-voltage power conversion — is to demonstrate R&D results from its 1200V GaN device.

The 1200V GaN device delivers greater than 99% efficiency and is said to perform well against a leading silicon carbide (SiC) MOSFET of similar on-resistance. Partially funded by the ARPA-E CIRCUITS program, Transphorm is developing the technology for electric vehicle (EV) mobility and infrastructure power systems as well as industrial and renewable energy systems. Transphorm says that the milestone further strengthens its ability to support the broadest range of power — from 45W to 10K+ kW — across the widest range of cross-industry applications compared with any other GaN supplier today, it is claimed.

The ISPSD presentation will provide detailed information of device configuration and performance analysis conducted using a hard-switched, synchronous boost half-bridge topology. The initial 1200V GaN device in a TO-247 package has an $R_{DS(on)}$ of 70mΩ and easily scales to lower resistance and higher power levels. Early results show notably low leakage with a breakdown voltage of greater than 1400V.

"Building on Transphorm's unique vertically integrated capability, our engineers have yet again pushed the limits of what's possible with GaN," says chief technology officer & co-founder Umesh Mishra. "We aim to bring to market an ultra-high-voltage, reliable GaN product that will give customers more choice when developing power systems. Our 1200V GaN FET will enable excellent performance with greater designability and cost effectiveness than SiC solutions," he reckons. "We see this as an important milestone for the GaN power electronics industry."

To date, commercially available high-power GaN transistors generally range from 600V to 650V, with the only 900V GaN device being available from Transphorm. The firm's core product portfolio consists of normally-off 650V devices in TO-XXX and PQFN packages, addressing one of the broadest range of power applications of any GaN provider in the market, it is claimed. This enables customers to leverage GaN's inherent advantages — high power density, high power efficiency, low switching loss, and lower overall system cost — while working with reliable devices that are easier to design in and drive versus alternative e-mode GaN or SiC options, the firm adds. Demonstrating the 1200V FET's performance promises to expand Transphorm's portfolio and ultimate market opportunity by supporting demanding, high-performance power system applications traditionally relying on SiC solutions.

"1200V GaN has been discussed within the industry for some time, but often perceived as rather difficult to achieve," comments Dr Isik Kizilyalli, associate director for Technology at the Advanced Research Projects Agency – Energy (ARPA-E). "As part of the ARPA-E CIRCUITS program led by the Illinois Institute of Technology, the Transphorm team has demonstrated an important breakthrough, showcasing GaN performance at the 1200V device node with high-efficiency 800V switching."

Transphorm's 1200V FETs are expected to be available for sampling in 2023.

www.ispsd2022.com
www.transphormusa.com
www.arpa-e.energy.gov/technologies/programs/circuits

MACOM awarded US DoD development contract

45kW RF transmitter uses GaN and antenna beam-forming technology

MACOM Technology Solutions Inc of Lowell, MA, USA (which designs and makes semiconductors, components and subassemblies for analog RF, microwave, millimeter-wave and photonic applications) has been awarded a contract from the US Department of Defense (DoD) to develop a high-power transmitter.

The contract requires MACOM to develop a 45kW radio frequency (RF) transmitter using gallium nitride (GaN) and antenna beam-forming technology. The solution is based on the company's proprietary MACOM PURE CARBIDE GaN components and power combining expertise.

"This award further validates that our semiconductor technology and engineering expertise is suitable for very high-power DoD programs," says president & CEO Stephen G. Daly. "We look forward to supporting this and other similar programs with our technology."

www.macom.com

LIQUID NITROGEN PIPING

Single phase, low pressure LN_2 to your use point for on-demand supply

- Clean, frost-free cooling to cryogenic temperatures
- Automatic LN_2 circulation for MBE cryopanels
- Variety of internal diameter piping to accommodate a range of flow rates
- Modular and re-configurable with vacuum jacketed feed-through connections

Since 1958

VACUUM BARRIER VBC CORPORATION

4 Barten Lane, Woburn, MA 01801
T 781 933 3570 | F 781 932 9428
sales@vacuumbarrier.com

vacuumbarrier.com

Odyssey demos 700V vertical GaN power FETs; targets 1200V next

US patent issued on fabricating high-voltage switching devices

Odyssey Semiconductor Technologies Inc of Ithaca, NY, USA says it has reached a technology milestone in its development of vertical GaN power field-effect transistors (FETs).

Global sustainability trends require new technologies and approaches for power conversion in electric vehicles, solar and wind turbines, data centers and industrial motors, notes the firm. The trend to depart from traditional silicon-based transistors has been underway for over a decade, as silicon can no longer meet the demanded voltage and conversion efficiency, it adds.

Deployed as lateral (or parallel) conduction FETs, GaN provides efficiency improvements but fails to provide the voltage rating required, Odyssey says. Silicon carbide (SiC) provides the voltage rating but falls short on efficiency.

Odyssey was founded to commercialize vertical GaN FETs, which can provide the conversion efficiency of GaN with the higher voltage rating of SiC.

Odyssey has now validated its approach at a 700V rating while also providing what is claimed to be industry-leading efficiency with low on-resistance approaching 1mΩ-cm^2. These devices also exhibit very low gate leakage and can be operated in a mode where they are normally off. Technology validation can begin on these 700V devices while an extension of the same architecture to the next milestone of a 1200V rating or better is completed.

Odyssey is developing the technology in its own 10,000ft^2 manufacturing facility (which has a mix of class 1000 and class 10,000 cleanroom space). The firm says that, as the US needs to strengthen domestic semiconductor manufacturing, it is showing its commitment with its own wafer fabrication plant. This also streamlines the technology and product development processes, with close collaboration between R&D and the fab, it adds.

Aso, on 15 February the US Patent and Trademark Office issued US patent 11,251,295 ('Vertical field effect transistor device and method of fabrication') with respect to key aspects of Odyssey's vertical GaN technology, relating to a method of fabricating a high-voltage switching device using GaN layers and materials. Odyssey now has two issued US patents, and has filed many other related claims for the vertical GaN device and related technology.

"This 700V milestone validates our industry-leading efficiency and remarkably low on-resistance. Odyssey is on-track to deliver 1200V vertical GaN FETs in 2022 for a handful of customers who have already requested engineering samples," says Rick Brown, co-founder, interim CEO, chief technology officer & board member. "Our patent is one of many that will help protect Odyssey's key aspects on our GaN devices," he adds. "Our goal is to fully protect our GaN devices using both patent rights and trade secrets."

Odyssey appoints Mark Davidson as CEO

Odyssey, which is developing high-voltage vertical power switching components based on proprietary GaN processing technology, says that Mark Davidson has joined it as CEO and member of the board of directors. He succeeds co-founder Rick Brown, who served as interim CEO since September 2021 and will continue as chief technology officer and board member.

"Odyssey is on-track to deliver 1200V vertical GaN FETs in 2022 for a handful of customers who have already requested engineering samples," notes chairman John Edmunds.

"Mark is known for his versatility to transform businesses into highly successful operations - having spent nearly 20 years working in Silicon Valley," comments Brown. "His leadership and experience will help our company achieve its full potential," he reckons.

Before joining Odyssey, Davidson was chief revenue officer of DreamVu, where he led commercialization and spearheaded revenue generation from scratch, leading the global sales expansion through his knowledge of global markets.

Prior to DreamVu, Davidson was CEO of Range Networks, where he pivoted its business model based on its technology leadership and the market opportunity, not only resulting in a surge in revenue and profitability but ultimately leading Range Networks to be acquired by a fast-growing company.

Davidson also has experience in power semiconductors. Previously, through Intel's acquisition of Altera Corp, he was Intel's VP/general manager, Global Power Products business organization, where he directed the transformation of a start-up company into a hyper-growth enterprise. Additionally, he has served as Texas Instruments' regional sales & applications engineering director, National Semiconductor's marketing director/product line director, Visteon Corp's Australian customer liaison engineer, and Ford Motor Company's product design engineer. He holds a Bachelor of Science degree in Electrical Engineering from Pennsylvania State University.

www.odysseysemi.com

AKHAN appoints Kirk Hasserjian to board

Ex-Intel, Applied Materials and GTAT exec to support operations, manufacturing cell optimization and overall growth plans

AKHAN Semiconductor Inc of Gurnee, Lake County, IL, USA — which was founded in 2013 and specializes in the fabrication and application of synthetic, lab-grown, electronics-grade diamond materials — says that Kirk Hasserjian has joined its board of directors, supporting the commercialization of its Miraj Diamond Platform.

"I've been very impressed by AKHAN's Miraj Diamond technology, the team, and its ability to serve and disrupt big markets," comments Hasserjian. "The company's inventions and R&D are exceptional — and I look forward to supporting their operations, manufacturing cell optimization and overall growth plans," he adds.

"I've had the pleasure of working with Kirk for many years at both Intel and Applied Materials, and know first-hand his amazingly diverse skillset," comments chairman of the board Tom Lacey. "His experience successfully scaling multiple technologies into high-volume markets [including AI/machine learning techniques for improved equipment performance] is directly relevant to our business objectives."

Hasserjian's career has spanned over 38 years in the high-tech arena with a variety of leadership roles in R&D, operations, manufacturing, development, and data analytics. He's held technical and management positions at Intel, Formfactor, and Applied Materials. He is also a former director on the board of silicon carbide (SiC) crystal growth firm GT Advanced Technologies (GTAT). Hasserjian received his Bachelor of Science degree in chemistry from the University of San Francisco and a Master of Science degree in chemical engineering from Stanford University.

"We are confident he will help us avoid potential pitfalls associated with the commercialization of new technologies and quickly achieve our high-volume production goals," says CEO Craig Mitchell.

www.akhansemi.com

'Women in Innovation' award for AFC's research director

Innovate UK funding for project developing high-throughput cleaning method for silicon carbide manufacturing

Engineering and materials science company Advanced Furnace Technology Ltd of Cambridge, UK (which provides specialist graphite services such as graphite cleaning, purification and coating) says that director of research Dr Zoe Tolkien has won £50,000 and a mentoring and support package as a winner at the 'Women in Innovation' awards of the UK Government agency Innovate UK (which provides funding and support for business as part of UK Research and Innovation).

The funding is for a project that will focus on developing a high-throughput cleaning method to reduce costs associated with manufacturing silicon carbide (SiC) devices for power electronic applications such as electric vehicles (EVs), wind turbines and solar panels.

"This award is continuing our reputation for innovation and enabling us to expand in high-growth markets," Tolkien comments. "As a female entrepreneur, I think one of the biggest challenges can be self-belief. The innovation space is very male-dominated and women don't often see themselves represented or feel inspired to get involved," she adds. "I think it's a challenge that needs to be addressed from a young age. Schools, parents and communities should encourage girls to innovate, be entrepreneurial and to lead," Tolkien continues. "Too often I see online talks aimed at women in business addressing the 'imposter syndrome'. It's sad that we are brought up to feel we're not good enough. I think change can only happen by changing the way we educate and talk to our girls from a young age."

Innovate UK launched Women in Innovation in 2016 after research revealed that just one in seven applications for Innovate UK support came from women. Boosting the number of female entrepreneurs could deliver £250bn to the economy, it is reckoned. The number of women leading applications for Innovate UK support has since increased by 70%, it is reckoned. The award program aims to empower female business leaders to develop commercially successful solutions to major social, environmental and economic challenges.

www.ktn-uk.org/programme/women-in-innovation

www.advancedfurnacetechnology.com

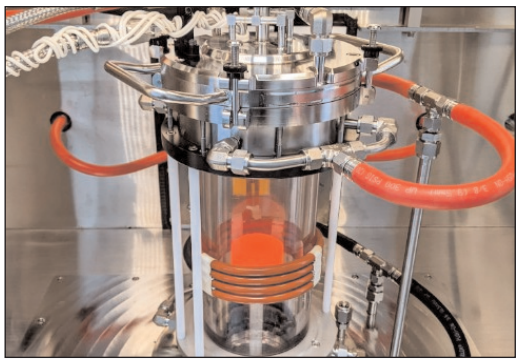
Bristol installs gallium oxide MOCVD system

First Ga_2O_3-based devices to be produced in next few months

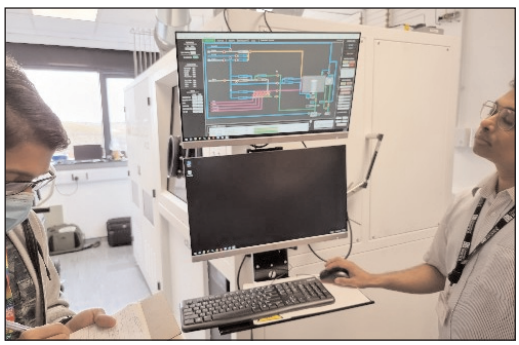
As the drive to cut carbon emissions intensifies and fuel costs soar (making need to reduce energy consumption even greater), a team at the University of Bristol has installed the UK's first metal-organic chemical vapor deposition (MOCVD) system for the epitaxial deposition of gallium oxide (Ga_2O_3), which can be used to make power electronics devices that could cut overall energy usage by about 20% in both domestic and industrial settings, it is reckoned.

"With the push to introduce more efficient power electronics and advanced renewable technologies amidst the pressing climate crisis, this presents a game changer for more sustainable and affordable future energy supply," reckons project lead Martin Kuball, Professor of Physics and the Royal Academy of Engineering Chair in Emerging Technologies.

"At present, nearly three-quarters (72%) of global primary energy consumption is wasted. While most low-carbon technology still relies on silicon-based electronic devices, we are slowly starting to see this replaced with semiconductors made from gallium nitride (GaN) and silicon carbide (SiC)," he adds. "As action to reduce our carbon footprint accelerates, a stronger focus on developing devices based on gallium oxide must happen and we are committed to progressing this at scale and speed."



Heart of the reactor in the MOCVD system. (Image courtesy of Cohen Rautenkranz, Agnitron Technology.)



Exterior of the MOCVD system. (Image courtesy of professor Martin Kuball.)

The 20-strong team of researchers is collaborating with other groups across the globe including in Japan, the USA and Germany, as well as industry partners such as Dynex Semiconductors. Funded in part by the UK Royal Academy of Engineering, the gallium oxide MOCVD system from Agnitron Technology in the USA is the first of its kind in Europe.

The MOCVD system will be used to grow thin layers of gallium oxide as well as aluminium gallium oxide. The resultant power electronics devices are even more energy efficient than existing GaN and SiC components, says Kuball. "We will be activating the machine this month and aim to have our first gallium oxide-based components within the next few months."

"Existing power converting units, often found in our streets, are container-size. Taking this technology to the next level could see them reduced to the size of a suitcase," says Kuball. "You could then build distributed power networks, or smart grids, because the compact proportions make it possible to have more of them widely distributed. This would lower the risk of power outages for large parts of the town or city, as is presently the case when a power line goes down," he adds. "The advantages of gallium oxide-based technology are vast. Now more than ever we must develop and refine the processes to fully realise this."

www.bristol.ac.uk/physics/people/martin-h-kuball/overview.html

CVD Equipment receives order for nine SiC PVT systems

Systems to ship in second-half 2022 to grow silicon carbide material for high-power electronics

CVD Equipment Corp of Central Islip, NY, USA (a designer and maker of chemical vapor deposition, gas control, and other equipment and process solutions for developing and manufacturing materials and coatings) has received an order for nine physical vapor transport (PVT) systems. Scheduled to ship in second-half 2022, the systems will be used to grow silicon carbide (SiC) material that is subsequently processed into wafers to support high-power electronics applications. This order is in addition to the order for six PVT tools that was previously announced in fourth-quarter 2021.

"Demand for SiC devices for high-power electronics continues to accelerate for electric vehicles, energy and industrial applications," says president & CEO Emmanuel Lakios. "We are committed to establishing a leadership role in manufacturing high-quality SiC production systems."

www.cvdequipment.com

IQE's full-year 2021 constant-currency revenue down a less-than-expected 7%

Longer-term cREO and QPC technology developments paused to focus on market-driven programs

For full-year 2021, epiwafer and substrate maker IQE plc of Cardiff, UK has reported revenue of £154.1m, above the £152m guidance but down 13.4% on 2020's £178m. However, the firm experienced a foreign exchange (FX) headwind of about £10.6m affecting GBP revenue on a reported basis, caused by the relative strength of Sterling versus the US dollar (in which most of IQE's revenues are denominated). On a constant-currency basis, revenue was down just 7.3% at £165m (in line with November's trading update of £164m).

Wireless revenue of £83.2m was down 11.6% on a reported basis and 5.5% on a constant-currency basis from 2020's £94.2m. Specifically, despite some softening of demand in the broader smartphone supply chain in Q4/2021, revenue grew by 19% for gallium arsenide (GaAs) epiwafers, driven by 5G penetration of the smartphone handset market and WiFi 6/6E as part of a multi-year replacement cycle driven by a macro technological trend. This resulted in high utilization of manufacturing capacity at IQE's Taiwan facility, where the firm has invested in eight new and refurbished tools — including three new Aixtron G4 metal-organic chemical vapor deposition (MOCVD) reactors — that are currently being commissioned to support further growth in demand in 2022 and beyond. This was offset by a 49% decline for gallium nitride (GaN) epiwafers used in 5G infrastructure. After a strong performance for GaN in 2020 resulting from the initial wave of 5G massive MIMO (multiple-input, multiple-output) base-station deployments (particularly in Asia), delays to further global deployments were experienced in 2021 (including a slow rate of deployments in Western markets). However, a multi-year replacement cycle is still anticipated for 5G infrastructure, including strong anticipated GaN content. Despite the decline in revenue, the Wireless business segment rose from 52.9% of total wafer sales in 2020 to 54% in 2021.

Photonics revenue of £68.1m was down 16.6% on a reported basis and 10.4% on a constant-currency basis from 2020's £81.6m (falling from 45.9% to 44.2% of wafer sales). Vertical-cavity surface-emitting lasers (VCSEL) revenue for 3D sensing applications was down by 19% as a result of smaller chip design sizes and a softening in smartphone supply chains towards the end of 2021, in line with seasonality and general softening in smartphone supply chains. IQE says that it maintained strong market share in its key supply chain and remains well positioned for future product evolutions. Infrared revenue is down 8%, due to the delay (into 2022) of certain defence aerospace and security orders associated with large programs being re-phased (with no loss of market share expected) as well as the slower introduction of sales of certain new products. InP and other revenues were up by 16%, predominantly due to strength in datacom and telecom markets as well as new growth areas of sensing.

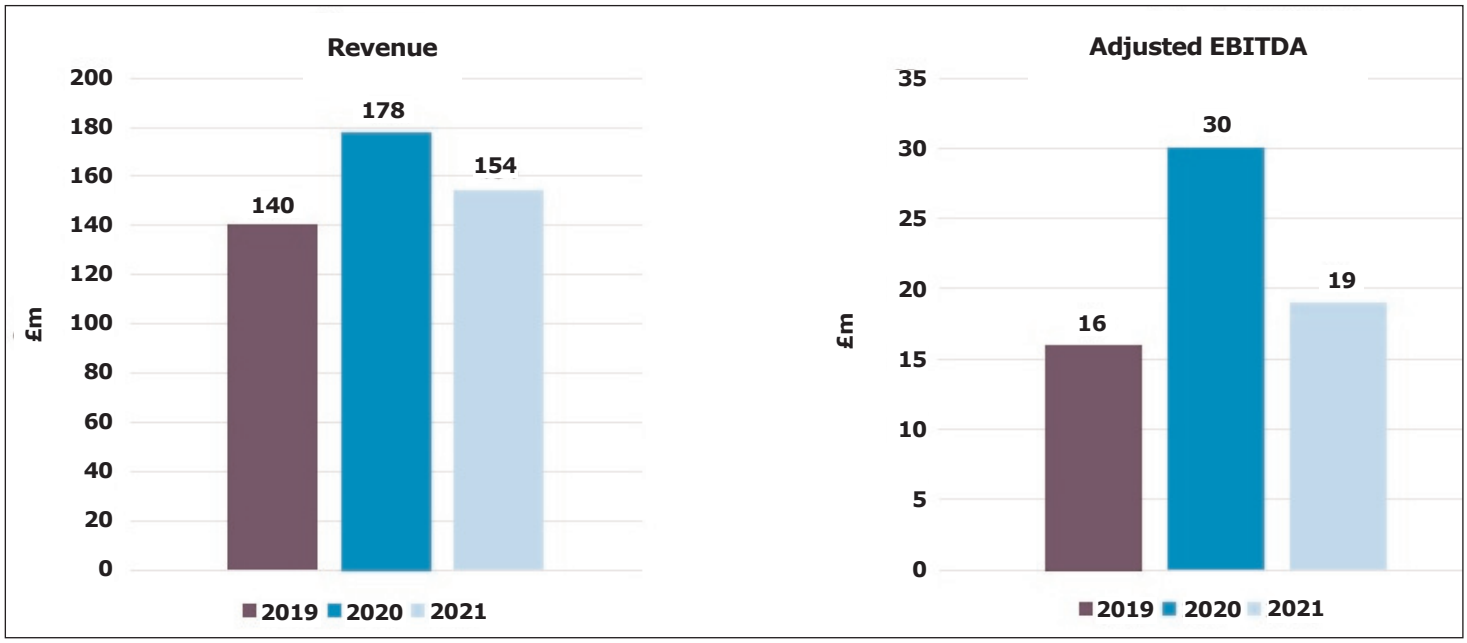
CMOS++ revenue of £2.8m was up by 28% on 2020's £2.2m (rising from 1.2% to 1.8% of total revenue), adding scale to IQE's silicon epitaxy operation (important to the integration of compound semiconductors on silicon, the firm notes).

IQE is in the process of improving its profitability through a global site optimization program and growing margins (in the medium to long term) by achieving higher volumes and hence economies of scale (improving production efficiency) at its strategic site locations. The global site optimization program involves:

- closure of IQE's Pennsylvania site and the associated consolidation of US-based molecular beam epitaxy (MBE) capacity into its larger and more scalable North Carolina site by 2024, incurring employee-related restructuring costs of £0.66m in 2021 (up from £0.16m in 2020);
- closure of IQE's Singapore site by mid-2022 (realising about £4.8m per annum of cash savings as part of the MBE consolidation plan), incurring restructuring costs of £3m in 2021 (£1.54m employee-related, plus £1.48m from site decommissioning);
- completion of the acquisition of minority interests in IQE Taiwan Corp in December 2021.

Due to the site closures, total restructuring-related exceptional costs of £3.68m have been recognized (classified as selling, general & administrative expenses).

Also, to focus the business, longer-term developments such as cREO (crystalline rare-earth oxide) filter technology and QPC (Quasi Photonic Crystal) are being de-prioritized in the short term to focus development programs on market-driven solutions. IQE says that it will retain the technology, capability and IP, enabling redeployment if and when appropriate commercial opportunities arise. IQE has hence recognized (in its reported operating loss): an exceptional intangible asset-impairment charge of £7.4m (including a non-cash impairment charge of £4.7m related to cREO development costs and patents); and a non-cash impairment charge of £2.7m for QPC and diffusers.



Excluding the exceptional charges totaling £13.5m, the adjusted operating loss (on a constant-currency basis) was £6.5m (compared with an operating profit of £5.4m in 2020).

Adjusted EBITDA (earnings before interest, tax, depreciation and amortization) has fallen from 2020's £30.1m to £18.7m on a reported basis. However, on a constant-currency basis this is equivalent to £25m, an EBITDA margin of 15% (down from 2020's 17% due mainly to IQE's operational gearing.

Net cashflow from operations has fallen from £35.5m to £18.9m, representing 96% conversion of adjusted EBITDA.

Capital expenditure on property, plant & equipment (PP&E) has tripled from £5m in 2020 to £15.1m in 2021 (below the prior guidance of £20–30m due to the phasing of payments for certain tool purchases into 2022), focussed on the deployment of additional tools to meet growing wireless GaAs epiwafer demand for 5G handset and WiFi 6 products in Taiwan.

This has resulted in a net debt position (excluding lease liabilities) of £5.8m at the end of 2021 (compared with net cash of £1.9m at the end of 2020).

IQE renewed a $35m revolving credit facility with HSBC bank in December and had a cash position at the end of 2021 of £10.8m.

IQE reckons that operations remain resilient in 2022 to the challenging macro-economic and geopolitical backdrop. The firm adds that it continues to monitor and work to mitigate potential headwinds in global semiconductor supply chains.

Business development progress during 2021 is listed as:

- a long-term strategic collaboration agreement signed with GlobalFoundries in Q4/2021 to develop vital gallium nitride on silicon (GaN-on-Si) technologies for mobile and wireless infrastructure applications;
- a multi-year strategic partnership signed in Q3/2021 with a major semiconductor foundry to develop epiwafers for 5G small cells in Asia.

Technology developments during 2021 include:

- expansion of the VCSEL portfolio with the turnkey IQVCSEL product line (with initial deliveries made to multiple customers);
- the achievement of key power and reliability milestones for IQDN-VCSEL technology for advanced sensing applications at longer wavelengths on 150mm GaAs substrates (relevant to future LiDAR technologies);
- scaling of VCSEL-on-Ge technology (IQGeVCSEL) to 200mm, enabling a step-change in industry economics in support of the broader adoption of 3D sensing.

"As the only global outsourced epitaxy provider and a leader in our field, IQE is uniquely placed to capitalize on major technological trends while navigating a challenging external environment," believes CEO Americo Lemos. "To secure this growth, we must first build a commercial engine that is orientated to our end markets, focussed on our customers and aligned with our technology innovation," he adds. "My vision is to grow IQE through multiple strategic and long-term customer relationships. We will be developing this strategy more fully during 2022."

IQE expects to grow revenues by a low single-digit % in 2022 (at constant currency), with growth weighted towards second-half 2022. At this level, IQE anticipates a similar adjusted EBITDA margin to 2021 (at constant currency). Capital expenditure of £10–15m is expected on PP&E and £6-8m on capitalized intangibles relating to development costs and IT transformation.

IQE says that in 2022 it aims to focus on building a platform for growth to deliver further progress in 2023 and beyond. The firm is confident that this refreshed strategy will enable a multi-year cycle of growth, driven by the macro trends of 5G, IoT and the Metaverse, as the global economy and semiconductor markets recover from current risks and disruption.

www.iqep.com

Wolfspeed buying Aixtron 6x200mm epi reactors for new Mohawk Valley silicon carbide fab

SiC-based MOSFET and Schottky diode power device production being ramped up

Deposition equipment maker Aixtron SE of Herzogenrath, near Aachen, Germany says that its 200mm Planetary Reactor technology is being deployed by Wolfspeed Inc of Durham, NC, USA for manufacturing silicon carbide (SiC) based MOSFET and Schottky diode power devices at its production facilities. Wolfspeed is currently ramping production in an automated 200mm silicon carbide wafer fab in Marcy, Mohawk Valley, NY.

"Silicon carbide is one of the key next-generation power management technologies. It allows us to write a new, highly exciting chapter in the development of the semiconductor industry and make an important contribution to energy-efficient technologies that support a sustainable future," says Aixtron's president & CEO Dr Felix Grawert. "Wolfspeed is at the forefront of 200mm silicon carbide production," he comments.

The new Planetary Reactors will be delivered in 6x200mm configuration, which is the largest capacity available to the market to date for silicon carbide epitaxy, representing a significant increase in total epitaxy area per batch compared with existing planetary systems. The product will be highly automated, enabling rapid exchange of parts without interfering with production cycles. The tools will also have temperature control technology for optimum on-wafer performance to match the quality requirements for epitaxial layers on silicon carbide wafers.

6x200mm configuration... is the largest capacity available to the market to date for SiC epi

"The demand for silicon carbide solutions continues to accelerate, primarily driven by the automotive, industrial and energy applications as they shift from silicon to SiC technology," says Wolfspeed's CEO Gregg Lowe. "Wolfspeed continues to make investments to increase capacity and capitalize on the benefits of silicon carbide to help deliver a greater supply to the market," he adds. "We appreciate our long-term, outstanding relationship with Aixtron. They are an important partner as we ramp production in the world's first 200mm silicon carbide fabrication facility."

www.aixtron.com

Veeco releases ESG goals for 2022 and beyond

Epitaxial deposition and process equipment maker Veeco Instruments Inc of Plainview, NY, USA has unveiled its Environmental, Social and Governance (ESG) goals for 2022 and beyond, showcasing its on-going commitment to corporate social responsibility. Based on feedback received from the company's stakeholders and results of its 2021 materiality assessment, the goals relate to climate change, product responsibility, diversity and inclusion, and responsible corporate governance.

Environment

- source 50% renewable energy for US operations by 2030 (previously disclosed in Veeco's 2021 Sustainability Report);
- by 2025, reduce normalized emissions from heating and purchased electricity (scope 1 and 2) by 10% in the USA from a 2021 baseline (emissions normalized to CO_2e per million dollars in revenue);
- introduce a comprehensive hazardous chemical management program focused on REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals), RoHS (Restriction of Hazardous Substances Directive), and TSCA (the Toxic Substances Control Act), partnering with a global leader to assist in compliance.

Social

- increase the representation of women at Veeco in the USA to 20% by 2025;
- increase the number of women and underrepresented employees at Veeco;
- continue to support diversity in science, technology, engineering and math (STEM) education through the Veeco STEM Scholarship fund in partnership with the National Association for the Advancement of Colored People (NAACP);
- make a material difference in our local communities through outreach and volunteerism.

Governance

- continue to expand and align our ESG disclosures with international frameworks and rating agencies.

"These goals build on the progress Veeco has made since the release of our first Sustainability Report in 2020," comments CEO Bill Miller. "Our long-term ability to execute on our vision of enabling a future where technology improves the human experience is dependent on our corporate sustainability," he adds. "We believe these goals demonstrate our commitment to sustainability by addressing the concerns of our stakeholders, improving our culture of inclusion, and minimizing our impact on the environment."

www.veeco.com/company/corporate-responsibilities

Nippon Sanso's first Ga_2O_3 MOCVD system qualified

Installation follows joint research with Tokyo University of Agriculture and Technology

Taiyo Nippon Sanso Corp (TNSC) of Tokyo, Japan has installed its first gallium oxide (Ga_2O_3) metal-organic chemical vapor deposition (MOCVD) system in the laboratory of professor Yoshinao Kumagai at the Tokyo University of Agriculture and Technology.

Beta-phase gallium oxide (β-Ga_2O_3) is attracting attention as a semiconductor material for next-generation power (and energy-efficient) devices. In October 2020, TNSC and Tokyo University of Agriculture and Technology began joint research on β-Ga_2O_3 thin-film growth by MOCVD, and in March 2021 they announced the successful MOCVD growth of β-Ga_2O_3.

TNSC says that its newly designed Ga_2O_3 MOCVD system (Model FR2000-OX, with a process capability of 1x2-inch wafer) will make it possible to fabricate complex device structures and further stimulate R&D of these materials.

Features include an MOCVD growth chamber for the high-purity and high-speed growth of oxides on β-Ga_2O_3 substrates to meet the needs of thick-film and alloy growth for research on high-performance electronic devices.

TNSC says that it will continue to enhance its Ga_2O_3 MOCVD technology to enable more energy-efficient semiconductor technology.

www.tn-sanso.co.jp/en
www.tuat.ac.jp/en

Riber's revenue up 3% in 2021, while net income grows fivefold to €1.5m, driven by diversification of product mix

For full-year 2021, Riber S.A. of Bezons, France — which makes molecular beam epitaxy (MBE) systems as well as evaporation sources and effusion cells — has reported revenue of €31.2m, up 3% on 2020's €30.2m.

MBE system sales were €17.4m, down 4% on 2020's €18.2m (with eight machines delivered, versus 10 in 2020). However, this followed the rejection by the French authorities of export licenses worth €9m in 2021.

Services & Accessories revenue maintained its strong growth, rising by 15% from €12m to a record €13.8m (44.2% of total revenue).

Due to a favorable change in the product mix and a rise in the value of the systems sold, gross margin has risen from 30.1% to 35.4%.

Operating expenditure rose from €8.4m in 2020 to €9.8m in 2021, due to R&D investment being increased by 80% to (€3.8m (12% of revenue). Sales & marketing costs were cut by 4% and administrative costs by 6%.

Operating income has grown from €0.7m to a slightly better-than-targeted €1.3m (rising from 2.3% to 4.1% of revenue). Likewise, net income rose from just €0.3m to €1.5m (from 0.9% to 4.7% of revenue). However, this included €0.4m of financial income and expenses, linked primarily to the revaluation in euros of receivables denominated in US dollars.

During 2021, the cash position fell by €2.2m from €8m to €5.8m, reflecting strong growth in cash flow from operations, an increase in working capital requirements, and the ramping up of investments.

Net debt was €2.4m at the end of 2021. During 2021, shareholders' equity rose by €0.8m to €19.8m, linked to earnings for the year and the distribution of amounts drawn against the issue premium for 2020 to shareholders.

The order book has grown by just 3% during 2021, from €14.4m to €14.8m. Specifically, following the major deliveries at the end of 2021, orders for Services & Accessories fell by 21% from €8.7m at the end of 2000, but remained at a good level of €6.9m end-2021. Orders for MBE Systems grew by 39% from €5.7m to €7.9m (three machines, including one production system). However, this excludes additional orders for six systems (five research and one production) announced during first-quarter 2022, worth a total of about €9m.

Outlook for 2022

Compared with 2021, Riber is forecasting growth in both revenue and profitability for 2022.

Also, due to a strong pipeline of prospects, the firm expects to continue to record new orders during second-quarter 2022.

Riber says that, over the longer term, in an environment supporting the emergence of a European semiconductor industry, it is moving forward with a project for profitable growth built around its technical and industrial know-how, as well as its capacity for innovation. Driven by new information technologies, the firm is rolling out a strategy focused on further strengthening its leading position in MBE, achieving regular growth in its service activities, and maintaining a robust level of R&D investment to expand its portfolio of technologies and applications.

Distribution of amounts drawn against 'issue premium' account

At the general meeting of shareholders on 21 June, Riber's executive board will submit a proposal to approve a cash payout based on reimbursing part of the issue premium for €0.05 per share (to be released for payment on 4 July).

www.riber.com

Taiyo Nippon Sanso and RIKEN demonstrate 226nm AlGaN-based DUV LED electroluminescence

SR4000HT system used in 3 x 2-inch wafer configuration

Tokyo-based Taiyo Nippon Sanso Corp (TNSC) and Japan's Institute of Physical and Chemical Research (RIKEN) in Saitama have demonstrated aluminium gallium nitride (AlGaN) deep ultraviolet (DUV) LED electroluminescence (EL) at a short wavelength of 226nm using TNSC's metal-organic chemical vapor deposition (MOCVD) equipment.

AlGaN-based deep ultraviolet LEDs with emission wavelengths of 220–350nm are applicable in a wide range of fields including sterilization, disinfection and medical applications. TNSC and RIKEN have conducted joint research for deep ultraviolet LED epitaxial growth and device efficiency improvement. Previously, 280nm emission wavelength was demonstrated using a TNSC SR4000HT MOCVD system in 4-inch wafer configuration. Now, electroluminescence emission with a short wavelength of 226nm has been report using the TNSC SR4000HT system in 3 x 2-inch wafer configuration.

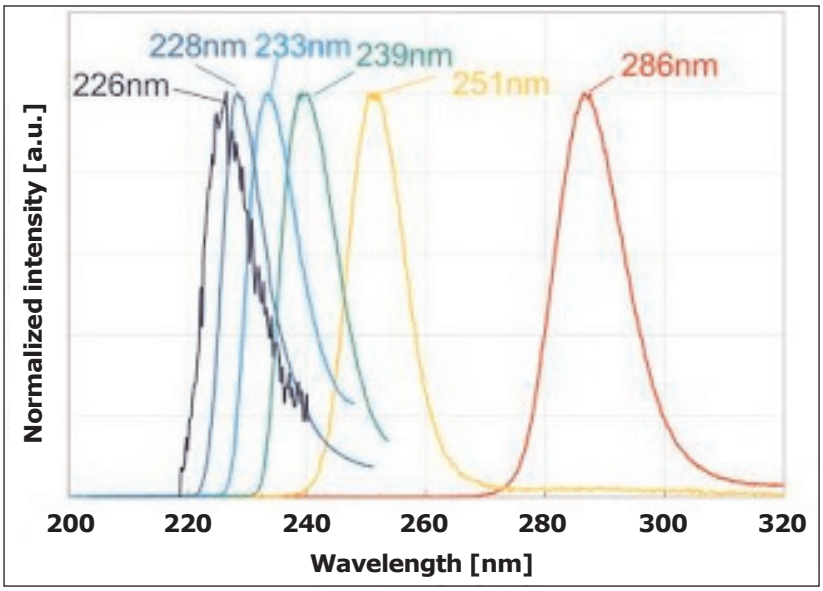


Figure 1. Electroluminescence emission spectrum of deep ultraviolet LED.

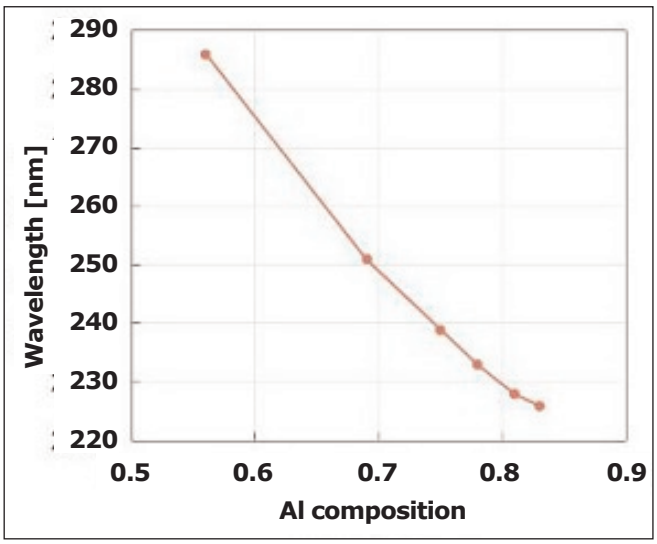


Figure 2. Relationship between Al composition and emission wavelength.

Figure 1 shows the electroluminescence emission spectrum at each wavelength, shortening from 286nm, and showing that an electroluminescence emission spectrum was obtained even at 226nm.

Figure 2 shows the relationship between the aluminium composition and each wavelength, indicating that the emission wavelength changes linearly with respect to aluminium composition.

www.riken.jp/en
www.tn-sanso.co.jp/en

SemiLEDs' quarterly margins rise as revenue recovers

Net losses cut by two-thirds from last quarter

For its fiscal second-quarter 2022 (to end-February 2022), LED chip and component maker SemiLEDs Corp of Hsinchu, Taiwan has reported revenue of $2.18m, up 48% on $1.47m last quarter and 82% on $1.2m a year ago.

Gross margin rebounded from 14% last quarter to 24%, exceeding the 20% a year ago.

Operating expenses have been cut from $1,181,000 last quarter to $902,000, although this is still up on $748,000 a year ago.

Operating margin recovered somewhat from –67% last quarter to –17%, an improvement on –42% a year ago.

Net loss has been cut by two-thirds from $518,000 ($0.12 per diluted share) last quarter to $172,000 ($0.04 per diluted share), which is also better than the $255,000 ($0.06 per diluted share) a year ago.

During the quarter, cash and cash equivalents fell further, from $4.1m to $3.7m (although this is an improvement on $2.1m a year ago).

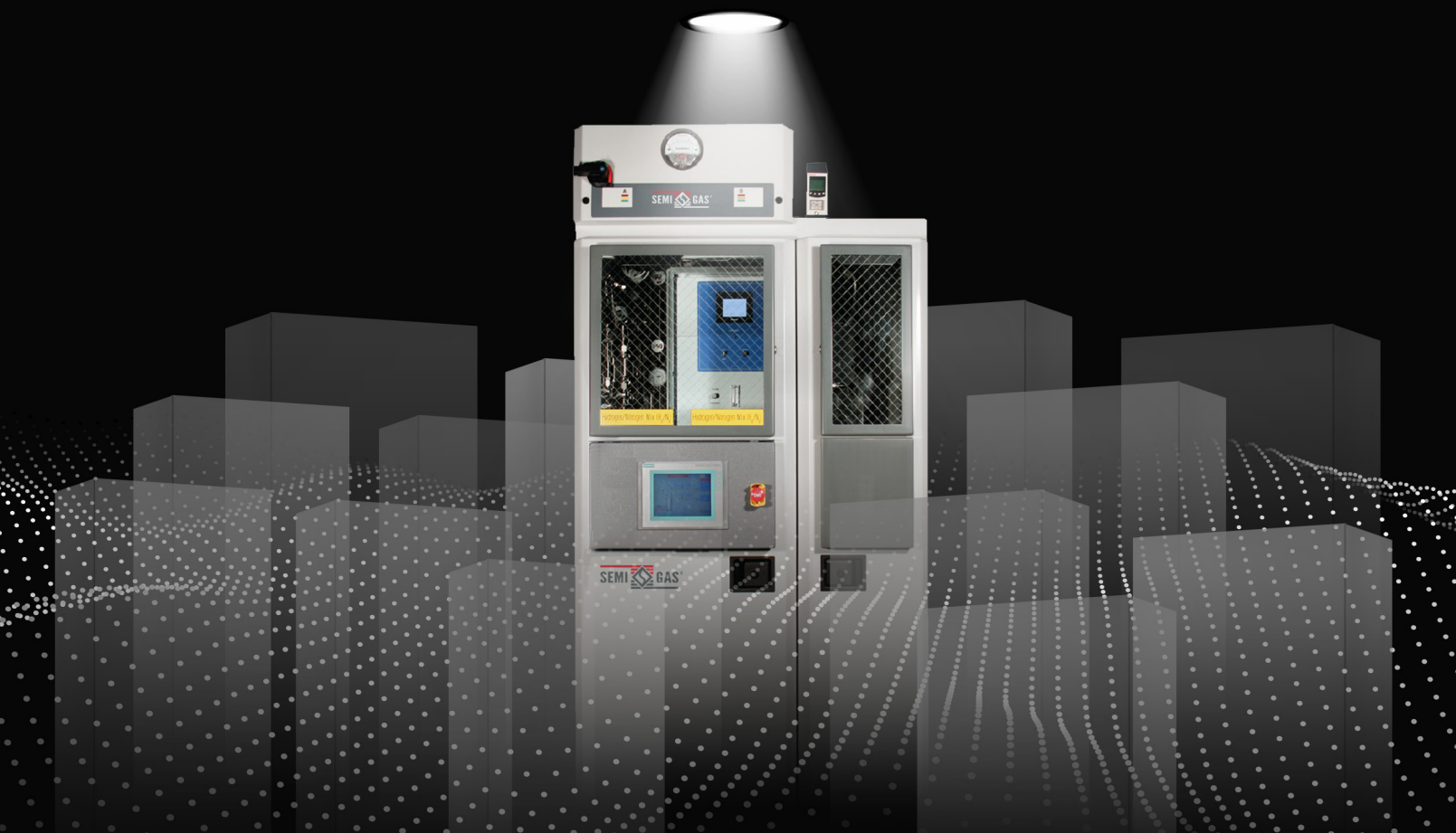
SemiLEDs says that, given the continuing uncertain impact of COVID-19 on the economy and the firm, it is unable to forecast revenue for fiscal third-quarter 2022 (to end-May) at this time.

www.semileds.com

SEMI GAS®

HIGH INNOVATION HAS HIGH STAKES.

Rise to new standards with SEMI-GAS®.



Semiconductors are mission-critical to many advanced applications today. Subpar gas delivery system performance not only inhibits output quality and reliability—it can also compromise safety.

For 40 years, SEMI-GAS® ultra high purity gas delivery systems have been relied upon by fabs looking to up their innovation, addressing evolving risks with features that don't just meet but exceed codes for safety, precision & purity.

BROUGHT TO YOU BY

APPLIED ENERGY SYSTEMS

Improve yield, ensure high-performance output, and protect the processes and people that make innovation possible with SEMI-GAS®. Start today at appliedenergysystems.com/stakes.

Seoul Semiconductor participates in ISAL 2022

Automobile division HQ relocating to Germany to focus on European and North American sales

At the 14th International Symposium on Automotive Lighting (ISAL) in Darmstadt, Germany (4–6 April), South Korea-based LED maker Seoul Semiconductor Co Ltd introduced a customized driving solution based on its LED technology for automobiles, and also proposed a new lifestyle in the future that provides a clean driving environment and safety for pedestrians.

Specifically, the firm presented various applications for exterior and interior use as follows: Violeds technology that sterilizes the surface and airborne viruses inside a car; automotive headlights, daytime running lights (DRLs), and micro-displays with WICOP (Wafer Integrated Chip on PCB) technology that does not require wire connection or a package; SunLike, a natural-light technology that protects the eyes of passengers and shows the natural texture of the interior; various sensing functions, from epi to infrared (IR)/VCSEL (vertical-cavity surface-emitting laser) sensor technology with Seoul Semiconductor's original technology.

Seoul Semiconductor's Violeds technology for vehicle sterilization (left) and WICOP technology applied to a micro-display (right).

In second-half 2022, Seoul Semiconductor is moving the headquarters of its automobile division to Germany, aiming to attract customers and to better meet their requirements.

Seoul Semiconductor files patent lawsuits against Philips' TV and filament LED bulbs

Ace Hardware and Conrad Electronic sued in Europe and USA

South Korean LED maker Seoul Semiconductor Co Ltd says that it has launched patent infringement lawsuits in the USA against global retail company Ace Hardware and in Europe against a distributor of Conrad Electronic's sales platform.

In the two cases, which are pending in the US District Court for the Eastern District of Virginia and the German District Court of Düsseldorf, Seoul asserted infringement of its patents by Philips brand TVs, filament LED bulbs, and premium lighting products. Seoul also sought a recall of infringing products as well as the destruction of those products in the German case.

In these lawsuits, Seoul's patents cover phosphor technology for high-quality color gamut and WICOP (Wafer-level Integrated Chip on PCB) technology.

Seoul says that it has developed its phosphor technology together with a Japanese company (M) over the last 15 years and has succeeded in producing LED lights that are the closest spectrum to natural light. Based on the quality of these lights, Seoul's phosphor technology can be found in premium lighting products requiring a color rendering index (CRI) of more than 90, as well as display products.

WICOP is a patented technology that is compactly designed without wire bonding or packaging, enabling LEDs to be mounted directly in a PCB assembly. The technology has been adopted in over models of 100 car (comprising about 10% of the global automobile market). The firm adds that it is also used in about 20% of the global TV market, as of 2020.

Seoul has already obtained permanent injunctions against various infringing products several times in Europe and the USA. In September 2020, the German District Court of Düsseldorf issued permanent injunctions, an order of recall and destruction against filament LED bulbs manufactured by a Phillips brand affiliate. In 2019 and 2021, the US District Court for the Central District of California and the New Jersey District Court issued permanent injunctions against the sales of a Philips TV product and 13 automotive lighting brand LED products, respectively.

www.SeoulSemicon.com

Seoul Viosys obtains permanent injunction against home electronics retailer Namsung America

SL Vionics' UV LED products alleged to infringe patented Violeds technology

Ultraviolet LED product maker Seoul Viosys Co Ltd (SVC, a subsidiary of South Korean LED maker Seoul Semiconductor Co Ltd) says that the United States District Court for the Middle District of Florida issued a permanent injunction against Namsung America Inc, which sold home electronics incorporating UV LEDs manufactured and supplied by SL Vionics Co Ltd (previously Semicon Light).

SVC says that, prior to the lawsuit, Namsung ignored its repeated notices of patent infringement. Since 2020, SVC has been requesting that companies stop selling SL Vionics' LED products. The firm believes that SL Vionics' LED products infringe its proprietary Violeds technology, which SVC invented and has been utilizing to produce its UV LED products. When Namsung continued selling products after notice, SVC filed the lawsuit, which asserted infringement of 11 patents.

The court's permanent injunction order applies to any colorable variations of the infringing products, as well as any parties who are in active concert or participation with making or selling such products.

"There are companies that seek to increase their profits by using other companies' patented technology," says SVC's CEO Young-joo Lee. "It seeks to cheat inventors everywhere who have invested and believed in their ideas."

SVC says that, to protect its technology and promote a fair marketplace, it actively pursues enforcement against suspected infringing UV LED products worldwide. As an example, it recently instigated a search and seizure of suspected infringing products against FNAC Darty Group, a large European retailer, and subsequently filed a patent infringement lawsuit in France. SVC also filed a patent infringement lawsuit against a European distribution company in the Netherlands, seeking a preliminary injunction against its UV LED products.

www.seoulviosys.com

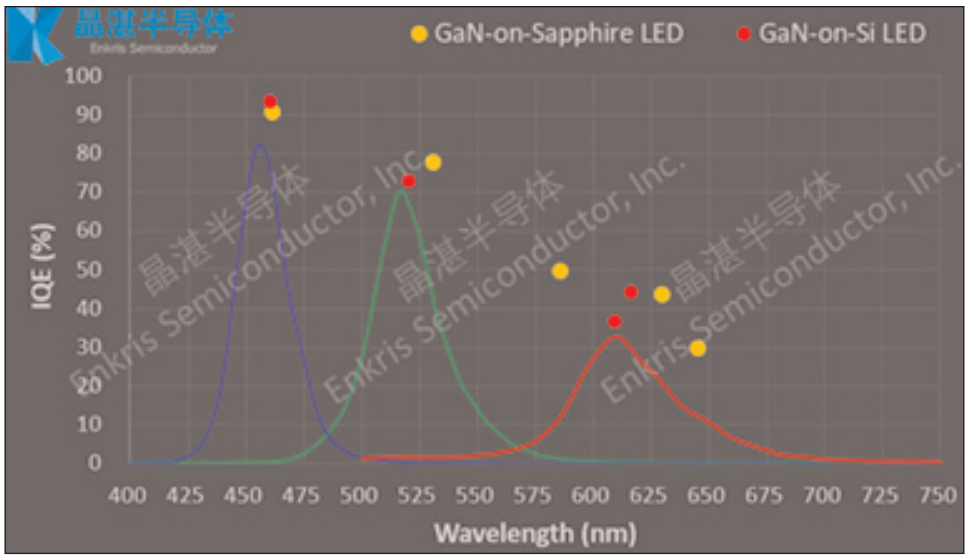
Enkris launches Full Color GaN products and expands wafer size to 300mm for micro-LED applications

RGB micro-LED arrays with 2–50μm pixel size demonstrated on 200mm epiwafers

Enkris Semiconductor of Suzhou Industrial Park, China — which is a pure-play foundry for gallium nitride (GaN) epitaxial wafers for power electronics, RF, micro-LED and UVC applications — has released its Full Color GaN RGB series of products with wafer size up to 300mm for the micro-display industry.

GaN-on-Si LEDs show advantages over those grown on other substrates for micro-LED technology in terms of larger wafer size (200–300mm) and better surface quality. Furthermore, by taking advantage of state-of-the-art silicon processing in 200mm/300mm fabrication plants, high-performance arrays of tiny (5μm^2) micro-LED pixels can be fabricated and integrated on a silicon CMOS driver with high yield.

Near-eye-displays such as augmented reality (AR) and mixed reality (MR) devices require high-efficiency, ultra-fine-pitch (<5μm) red, green and blue pixels integrated on the same material platform. Indium gallium nitride (InGaN) materials can emit light efficiently, spanning the entire visible spectral range by adjusting the indium content. Although high-efficiency blue and green InGaN LEDs have been achieved, it is still very challenging to grow high-efficiency red LEDs due to the pronounced strain in the active region and the poor crystalline quality resulting from the large lattice mismatch between InGaN quantum wells (QWs) and GaN buffers. Enkris Semiconductor has successfully overcome these difficulties by using its patented strain engineering and polarization engineering (see Figures). By adopting its unique bandgap tuning technology, Enkris has expanded its GaN-on-Si LED epiwafer product portfolio to the Full Color GaN RGB series of products (with wavelengths of 390–650nm) on 200mm silicon substrates.



IQE comparison and EL spectra of Full Color GaN RGB series of products on silicon and sapphire.

Enkris has also demonstrated RGB micro-LED arrays with a pixel size ranging from 2μm to 50μm

Wavelength uniformity is a key factor for micro-LED displays. Enkris says that its Full Color GaN RGB series has excellent wavelength uniformity across the whole 200mm wafer. Moreover, GaN-on-Si blue LED wafers are available up to 300mm in diameter, and the wavelength is reasonably good, with a standard deviation of less than 2nm.

Enkris has also demonstrated RGB micro-LED arrays with a pixel size ranging from 2μm to 50μm, based on Full Color GaN RGB series of 200mm epiwafers. Thanks to the high-quality epiwafers, all the pixels can be lit up, even for each 2μm^2 pixel (in a 100 x 100 array). This is the key accelerator for micro-display adoption, it is reckoned.

"For monolithic integration of micro-LEDs, it is a critical step to integrate all three colors into a single material platform of large-size GaN-on-Si," says founder & CEO Dr Kai Cheng. "Our Full Color GaN series products will fulfil the industry's requirement for AR/MR systems. In addition, the GaN-on-Si wafer size can be scaled up to 300mm, and we presented a 1200V 300mm GaN-on-Si platform in September 2021. The new platform of 300mm GaN-on-Si LEDs will show great promise in heterogeneous integration of GaN optical devices, GaN electronic devices and silicon devices," he adds. "Enkris is now able to supply a true RGB GaN-on-Si epitaxial solution for the display industry and empower the development of full-color micro-displays."

Enkris's Full Color GaN series products are available on both GaN-on-Si and GaN-on-sapphire.

Enkris expresses its gratitude to Raysolve for the support during device validation and evaluation of GaN epitaxial materials.

www.enkris.com

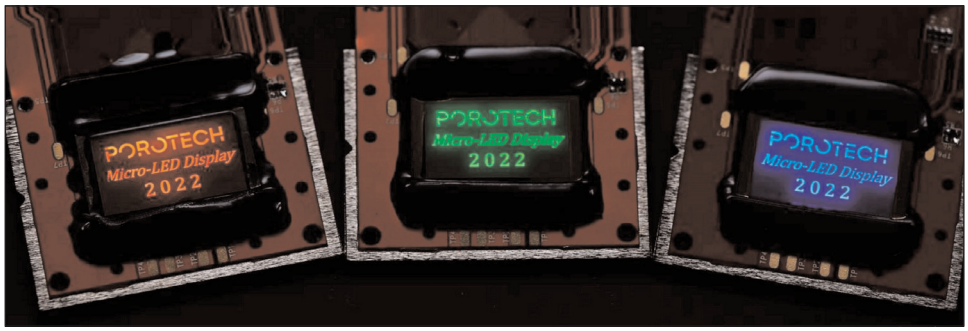
Porotech showcases brightest native full-color InGaN-based micro-LED display projections at Touch Taiwan

Native InGaN-based R/G/B on a single material and tool chain to accelerate micro-LED commercialization

At the Touch Taiwan – Display International event in Taipei (27–29 April), Porotech (which was spun off in 2020 from the Cambridge Centre for Gallium Nitride at the UK's University of Cambridge) is showcasing what it says is the first set of native indium gallium nitride (InGaN)-based red, green and blue micro-LED displays at 1920 x 1080 resolution with at least 2 million nits of brightness (≥2m nits).

Porotech claims to be first in the industry to demonstrate all three color light-emitting elements produced with a single material and toolchain, enabled by its PoroGaN micro-LED technology platform — including a native red InGaN display at 614–625nm wavelength. The platform's proprietary subsurface porosity technology enables a dramatic increase in brightness and efficiency in all three primary colors, while its scalable architectures are said to simplify the manufacturing processes, thus reducing cost, which are all critical requirements for the commercialization of micro-LED displays for next-generation consumer augmented/mixed/virtual reality (AR/MR/VR) glasses, smart wearables and smart displays.

Until now, the requirement to mix multiple material systems has complicated the manufacture of full-color displays in the micro (μm)- or nano (nm)-pixel space, due to the marked drop in efficiency of the red sub-pixel with decreasing pixel size. "Our deep material technology has unlocked the ability to produce micro-LEDs with high brightness and color uniformity for RGB grown on a single InGaN-based material system and produced with a single tool chain," says CEO & co-founder Dr Tongtong Zhu. "This will enable a wide range of use cases for optical system designs while optimizing micro-display manufacturing and improving yield for mass production," he adds. "Meanwhile, we have been working on full-color InGaN-based monolithic micro-LED displays, and expect to be making an exciting announcement to the public very soon."



Enabled by the proprietary technologies, the PoroGaN platform has made it possible to produce a 614–625nm-wavelength InGaN red display as well as 536–543nm InGaN green and 444–447nm InGaN blue displays. At Touch Taiwan, the company will be demonstrating how the platform facilitates emission across a wide spectrum of wavelengths, from blue to green and into the reddest red ever natively produced from InGaN.

Recently, Porotech created what is claimed to be the first micro-LED display based on native red InGaN — with an active area of 0.55-inches diagonally and a resolution of 960x540. In early 2022, the firm secured $20m Series A investment to accelerate global expansion and mass production of its micro-LED products.

Following the Touch Taiwan exhibition, Porotech will introduce its dynamic pixel tuning capability to address the full color spectrum at SID Display 2022 in San Jose, CA, USA.

www.porotech.com
www.touchtaiwan.com/en

Luminus launches Generation 4 high-density COBs with Robusto technology

Enhanced lumen maintenance and color stability at high temperatures

Luminus Devices Inc of Sunnyvale, CA, USA — which designs and makes LEDs and solid-state technology (SST) light sources for illumination markets — has launched its next generation of high-lumen-density white COB arrays featuring Robusto technology, the latest enhancement to improve maximum operating temperature.

High-lumen-density parts are used in narrow-beam applications where center-beam candle power (CBCP) is the key metric. While this depends on the specific beam angle and power level, the high-lumen-density parts typically deliver at least twice the lumen density of standard parts. Higher-temperature operation means more luminaire design flexibility and lower potential cost with, for example, smaller, lighter heat sinks.

These Generation 4 high-lumen-density parts provide stable lumen output and color points with temperatures as high as T_c = 120ºC. Robusto technology has the ability to enable higher drive currents while still delivering what is claimed to be exceptional lumen maintenance (L_{90}>55k hrs) and remarkably stable color points.

The new line of COBs has what is said to be outstanding color quality, high lumen intensity, and the industry's best flux and color stability over their operating life, all of which suits narrow-beam, high-CBCP applications in retail and shop lighting, hospitality lighting, architectural and specialty lighting.

"The new Generation 4 high-lumen-density parts offer the ultimate in COB flux density," says David Davito, COB product line director, Illumination. "This is complemented by Robusto technology, which enables higher operating conditions while maintaining steady lumen maintenance and color stability," he adds. "With Robusto technology, Luminus' high-density COBs are able to provide customers with higher levels of CBCP, consistent color and flux over the life of the luminaire."

Luminus releases MP-5050-250R high-efficacy mid-power LEDs

Up to 185lm/W, high PPF/W, and CRIs of 70, 80 and 90

Luminus has announced the launch and availability of a new high-efficacy family of 5050 mid-power LEDs designed with sulfur resistance for high-performance and long-term reliability in outdoor lighting and horticulture applications.

The new MP-5050-250R high-performance LEDs provide low thermal resistance, up to 185lm/W high photosynthetic photon flux (PPF)/Watt, and color rendering index (CRI) options of 70, 80 and 90 minimum. In addition, they are compatible with automatic placement equipment and are RoHs and REACH compliant.

Customers who are listing their products with DLC can leverage the MP-5050-250R series' 17,000-hour LM-80 report under a wide range of operating conditions. The MP-5050 mid-power LEDs allow illumination engineers and designers to develop lighting solutions with maximum efficacy, brightness and overall quality, says the firm.

"Our customers are turning to 5050s to replace multiple 3030s in horticulture or to replace 3535 die-on-ceramic LEDs in outdoor applications," notes Tom Jory, VP of illumination marketing. "The 250R series, with sulfur resistance and best-in-class efficacy, is now our flagship in the 5050 line, which we will continue to expand with more voltage options in the near future."

www.luminus.com

Lumileds fully transitions to renewable electricity at Penang plants

Emissions cut by over 40,000 tons of CO_2 annually

Lumileds LLC of San Jose, CA, USA says that, as of 18 March, it has fully transitioned to 100% renewable electricity at its two manufacturing locations in Penang, Malaysia (reducing emissions by more than 40,000 tons of CO_2 equivalent every year).

Lumileds describes this as a significant step forward towards fulfilling its strategic initiative to completely transition to electricity from renewable energy sources while at the same time contributing to Malaysia's national vision to accelerate the development of renewable energy.

The transition has been made possible by the Green Electricity Tariff (GET) program, launched by the Ministry of Energy and Natural Resources (KeTSA) in partnership with TNBX Sdn Bhd (a subsidiary of Tenaga Nasional Berhad) in November 2021.

"Lumileds is committed to taking urgent action to combat climate change by developing energy-efficient LED lighting solutions and our ongoing commitment to reduce greenhouse gas (GHG) emissions in our operations," says CEO Matt Roney. "Adopting the Green Electricity Tariff for our manufacturing sites in Penang is an important milestone on our sustainability journey and corresponds to a greater than 40% reduction of our carbon footprint from our worldwide operations," he adds.

"Sustainability has always been the State's utmost priority, and we are making palpable inroads along the journey," comments Right Honourable Chow Kon Yeow, Chief Minister of Penang. "In the face of climate change, the adoption of renewable energy is a critical component in reducing greenhouse gas emissions and the race towards zero-emission," he adds. "Lumileds' complete adoption of renewable energy in both its manufacturing plants not only exemplifies its outstanding corporate citizenship in leading the way on sustainable practices but also concurs with the State's aim in building a resilient and sustainable ecosystem."

Lumileds issues 2021 Sustainability Report

Scope 1 and 2 carbon footprint reduced by over 40%

Lumileds LLC of San Jose, CA, USA has issued its 2021 Sustainability Report, which details its progress in supporting the transition to a low-carbon and sustainable economy. In the report, Lumileds highlights how its lighting solutions contribute to positive changes in energy usage, safety, and health and well-being. The firm follows a formalized sustainability agenda that identifies specific priorities and tracks progress.

Lumileds' sustainability efforts are aligned with the United Nations Sustainable Development Goals (SDGs), and the firm has identified four SDGs where the most significant contribution can be made: Good Health and Well-Being, Affordable and Clean Energy, Responsible Consumption and Production, and Climate Action.

Lumileds says that it is committed to taking urgent action to combat climate change by developing energy-efficient LED lighting solutions and through its ongoing commitment to reduce greenhouse gas (GHG) emissions in its operations. In 2021, the company averted 8.60 million metric tons of use-phase carbon dioxide (CO_2) through its LED products.

Lumileds also reports a significant step forward towards fulfilling its strategic initiative to completely transition to electricity from renewable energy sources. Operations in Malaysia fully transitioned to 100% renewable electricity, and operations in the USA transitioned to at least 40% renewable energy. This allows the firm to reduce its Scope 1 and Scope 2 carbon footprint by more than 40%.

"Despite ongoing challenges associated with COVID-19 and other disruptive global events, the urgent need to accelerate decarbonization across the world has been top of mind," says CEO Matt Roney. "As such, we are unwaveringly committed to reaching our sustainability goals, motivated by the 1.5ºC warming scenario boundary," he adds. "Our scientists and engineers continue to increase product performance while achieving significant reductions in energy use, carbon emissions, and water consumption."

Lumileds also highlights how new micro-LED technology can further support carbon footprint reduction through energy-efficient applications and enhance safety in automotive lighting applications. In the area of vehicle safety, the report covers the road-legal approval for LED retrofit light sources in South Korea, Germany, Austria and France, bringing the safety benefits of LED lighting to new cars and, importantly, to cars already on the road.

Other highlights covered in the report include safety awards for Lumileds' manufacturing sites in Poland and Malaysia, underlining health and safety as Lumileds' highest priority.

www.Lumileds.com/sustainability

LUXEON SunPlus portfolio gains high-power deep-red HPE variant

660nm deep-red LED complements SunPlus 3030 and 5050 white LEDs for horticulture lighting

LED maker Lumileds of San Jose, CA, USA has launched the LUXEON SunPlus HPE, a high-power, deep-red (660nm) LED designed specifically for the horticulture lighting industry.

LUXEON SunPlus HPE is claimed to achieve the highest PPF (photosynthetic photon flux) and PPE (photosynthetic photon efficiency) from its industry-standard 3.5mm square ceramic package. The new deep-red LED is part of the SunPlus horticulture portfolio that spans a broad range of wavelengths and colors (including white, purple and lime) in a variety of mid-power, high-power and CoB (chip-on-board) packages, which offers flexibility to growers to create a specific lighting mix required for various types of crops.

"Much of the horticulture market is adopting solutions that use a mix of white and deep-red LEDs," says senior product marketing manager LP Liew. "The new LUXEON SunPlus delivers top-notch performance," he claims. "And it's available with extremely short lead-times… It's the highest-performing LED and its shipping."

The LUXEON SunPlus HPE has the robustness to stand up to harsh horticulture environments and deliver the longevity expected of all LUXEON LEDs, says Lumileds. "It pairs exceptionally well with our high-efficacy LUXEON SunPlus 3030 and 5050 LEDs, the two most commonly deployed white LEDs," Liew continues. "This white and deep-red horticulture combination can significantly drive down the system cost and reduce operating costs due to the solution's superior efficacy."

With its industry-standard package, the LUXEON SunPlus HPE has various off-the-shelf optical solutions available to enable designers to select the right viewing angles to achieve the appropriate intensity of light for the crops. LUXEON SunPlus is a single portfolio engineered to address the full breadth of horticulture lighting applications, says Lumileds.

https://lumileds.com/products/horticulture-leds

LUXEON SunPlus 3030 & LUXEON 3030 HE Plus LEDs for horticulture and illumination get performance boost

Lumileds has announced a new, higher performance level consisting of 21 new parts for its horticulture and illumination mid-power 3030 LEDs. Typical flux, PPF (photosynthetic photon flux) and efficacy have increased by 2%. In a luminaire consisting of hundreds of LEDs this is important and, implemented throughout a greenhouse or in a vertical farm for example, it can have a tremendously positive impact on cost and energy use, says Lumileds. The new parts have correlated color temperatures (CCTs) of 2200–6500K and color rendering indexes (CRIs) of 70, 80 and 90. LUXEON SunPlus 3030 (previously known as LUXEON 3030 HE Plus for Horticulture) is specified for PPF and PPE (photosynthetic photon efficiency) for horticulture while the LUXEON 3030 HE Plus is specified in flux and efficacy for illumination.

Both 3030 white LED portfolios are engineered for robustness and consistency and easily outperform competitors in tests for wet high-temperature operating life (WHTOL) and hydrogen sulfide (H2S). LUXEON 3030 LEDs pass 85°/85% relative humidity testing at 30 minutes on/30 minutes off at 480mA for 1000 hours. Lumileds says that it follows the JIS C 60068-2-43 test condition for H2S testing, and LUXEON 3030 LEDs perform exceptionally well under these conditions at 15ppm H2S, 40°C, relative humidity of 80%, it is claimed. Further testing shows color shift, measured as DuV, to be less than half of competitors.

"While industry datasheets can be good for showing perfect world performance, our LEDs need to perform in tunnels, along roadways, in greenhouses, and in vertical farms. These are harsh, wet and humid environments," says product manager Tiger Xue. "LUXEON SunPlus 3030 and LUXEON 3030 HE Plus are designed to perform at the highest levels for tens to hundreds of thousands of hours not on paper but in real-world environments. And, with the increased performance, narrowest V_f range and tightest color consistency, they deliver exceptional value," he adds.

LUXEON SunPlus 3030 and LUXEON 3030 HE Plus are immediately available through Lumileds' distribution network and are part of the Zero Worry Lead Time program from Future Lighting Solutions.

www.lumileds.com/products/horticulture-leds/luxeon-sunplus-3030
www.lumileds.com/products/mid-power-leds/luxeon-3030-he

Lumileds expands LUXEON 5050 HE LED range with higher CRI and efficacy

Now available at CCTs of 2200–6500K with CRI of 70 or 80, and CCTs of 2700–5700K with 90 CRI

Lumileds says that, in response to market demands for better outdoor and industrial light and very high efficacy, it is expanding its LUXEON 5050 HE LEDs (launched last November) with new 80 and 90 CRI (color-rendering index) parts while simultaneously increasing the luminous efficacy of the parts that are available in both 6V and 24V configurations.

"When given the choice, OEMs and end-customers want higher-quality light, inside or outside, and they want it to be as efficient as possible," says product line manager Mei Yi. "While others chose not to offer complete portfolios, we believe that supporting the broad range of applications, regional preferences and requirements for light is the correct approach," he adds. "Thanks to our phosphor, chip and package expertise, we are able to provide the range, quality and robustness to support the most demanding applications."

LUXEON 5050 HE delivers what is claimed to be industry-leading lm/W performance in high-sulphur environments. Its footprint compatibility makes it easy to design into existing and new platforms, says Lumileds. In particular, LUXEON 5050 HE is suitable for outdoor, industrial and horticulture applications where robustness, longevity and efficacy are the driving attribute.

LUXEON 5050 HE is immediately available in versions with correlated color temperatures (CCTs) of 2200–6500K with a color-rendering index (CRI) of 70 or 80, and CCTs of 2700–5700K with 90 CRI. The LED is characterized for both illumination and horticulture applications with lumen and efficacy ratings as well as photosynthetic photon flux, PPF (µmol/s), and PPF/W (µmol/J).

Production orders can be placed now for short lead-time delivery through Lumileds' distribution network.

www.lumileds.com/LUXEON5050HE

LUXEON 2835 Color Line lumen performance gets boost

Red, Blue, and Royal Blue fluxes increased by 10% or more

Lumileds has announced a boost in luminous flux to its LUXEON 2835 Color Line family of color LEDs. Specifically, Red, Blue and Royal Blue get flux increases of 10–13%.

"Expanding the color options and improving performance are an ongoing priorities for the portfolio," says product marketing manager LP Liew. "From aquariums to schools and pools to ships, the range of applications and the market demand for high-quality, reliable and efficient color LEDs continues to grow."

LUXEON 2835 colors span the range from Royal Blue to Far Red. Five of the colors are phosphor converted, including PC Blue, Lime, Mint, PC Amber and PC Red-Orange. The phosphor-converted LEDs offer additional options for flux and efficacy. The portfolio's white LEDs are offered in versions with correlated color temperatures (CCTs) of 3000K, 4000K and 5700K.

The LUXEON 2835 Color Line complements Lumileds' white 2835 portfolios, LUXEON 2835 Architectural and LUXEON 2835 Commercial. To further speed the design and manufacturing of new lamps, the LUXEON 2835 Color Line features identical polarity on every color, simplifying PCB design.

www.lumileds.com/products/color-leds/luxeon-2835-color-line

Lumileds launches LUXEON 3528 RGB LED

Lumileds LLC of San Jose, CA, USA has released its new LUXEON 3528 RGB, a very small, slim RGB LED package that supports a broad range of architectural, decorative and color-changing applications. The firm says that the white body increases reflectivity and system lumens per watt and system efficiency. The IPX8 water-resistant rating allows for use in moist environments inside or outside a building.

"LUXEON 3258 RGB just makes it easier for our customers to develop innovative color-changing solutions. It does this by offering leading performance in all three colors, by ensuring that the package design and its color optimize efficacy, and by making sure that it can operate in a wide range of environments," says product marketing manager LP Liew. "With the IPX8 rating and LUXEON reliability and quality, this new LED package is equally at home inside or outdoors. LUXEON 3528 is more than just the sum of its features, it's the complete RGB package."

For linear, flexible, and other solutions that also incorporate white, LUXEON 3528 RGB can be easily paired with LUXEON 2835 Architectural white LEDs to optimize color changing in a wide variety of environments.

www.lumileds.com/products/color-leds/luxeon-3528RGB

ams OSRAM investing €800m over next 18–24 months on new 8" LED front-end fab

At its Capital Markets Day (CMD) on 5 April, ams OSRAM GmbH of Premstätten, Austria and Munich, Germany provided investors with an update on its strategy, business outlook and targeting optical solutions, showcasing the opportunities since it has been on an integration path after ams gained operational control of OSRAM in March 2021.

"We have a compelling strategy, anchored by major technologies, that will drive the demand for optical solutions in markets in which we are active and holding leading positions," believes CEO Alexander Everke. "This is underpinned by the diversity of our revenue growth vectors in our Semiconductors business, across the Automotive, Consumer, Industrial and Medical end markets. The confluence of these factors will create the foundations of sustainable and responsible success," he adds.

In particular, the CMD focused on the following:

- confirming the firm's targeted financial model, providing more underpinning regarding the key drivers of the long-term target model of double-digit average annual revenue growth and 20+% adjusted EBIT margin;
- introducing 2024 mid-term targets of €4.9bn±€300m revenue and adjusted EBIT margin of 15% or better, on the basis of the re-aligned portfolio; and
- showcasing the firm's technology position in key growth applications including advanced dynamic automotive lighting, micro-LED display technology, optical solutions for augmented reality/virtual reality (AR/VR), automotive sensing, and horticulture LED lighting.

The firm also presented its future industrial footprint. Along with a range of consolidation steps, ams OSRAM will build a new 8"-wafer LED front-end fabrication plant alongside its existing LED fab in Kulim, Malaysia, adding significant capacity to support expected growth in advanced LED technologies and micro-LEDs. The new facility investment is expected to amount to about €800m over the next 18–24 months.

ams OSRAM says that, since March 2021, it has already made significant progress with a range of key milestones achieved, despite end-market and supply chain headwinds over the last 12 months. At the same time, ams OSRAM is making progress in divesting non-core businesses through the sale of the majority of the former OSRAM Digital business (due to be completed by year-end 2022) and the completed unwinding of the former OSRAM–Continental joint venture.

Also, as part of the definition of its ESG strategy, ams OSRAM has published its first key targets: to be carbon neutral by 2030 and to have 25% of leadership positions held by women in 2026.

www.ams-osram.com

ams OSRAM selling Automotive Lighting Systems business to Plastic Omnium

ams OSRAM has agreed to sell its independent AMLS (Automotive Lighting Systems GmbH) business to Plastic Omnium for €65m.

With about 770 staff at nine sites worldwide (including 120 engineers working in five R&D facilities), AMLS revenue was €148m in 2021. Based in France, Plastic Omnium is a strongly growing automotive tier-1 supplier group with 30,000 staff and annual revenue of €8bn in 2021 from a global customer base.

The deal is a further step in the implementation of ams OSRAM's strategy to focus on dedicated strategic core technology and to divest businesses that are not seen as core to the corporate strategy. ams OSRAM will continue to be a key supplier of automotive LEDs and optical components to Plastic Omnium. The deal does not include other ams OSRAM technologies and products for automotive OEM and the automotive after-market.

ams OSRAM Automotive Lighting Systems was established on 1 October 2021 following the dissolution of the OSRAM Continental joint venture. Based in Munich, AMLS combines lighting technology with electronics and software to develop smart full lighting systems for the automotive industry.

ams OSRAM will continue to provide high-tech innovation in components for automotive, including automotive lighting, covering the entire light spectrum – from visible to invisible light – and sensing applications for the automotive industry. This includes key automotive technology to support optical applications such as driver and interior monitoring, dynamic and static exterior lighting, RGB interior lighting, light detection & ranging (LiDAR) for autonomous driving and advanced driver-assistance systems (ADAS), head-up displays, and gesture sensing.

"Our portfolios are highly complementary; together we expect to expand our market access and we share a similar mission and mindset," says AMLS' general manager Dr Dirk Linzmeier. "We look forward to joining Plastic Omnium to establish a strong mobility lighting player built on AMLS' portfolio of innovative technologies," he adds.

The transaction is expected to be finalized in third-quarter 2022.

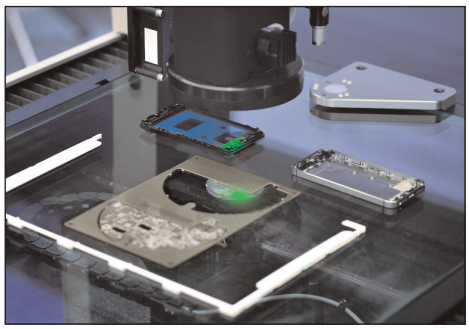
ams OSRAM green laser diode offers 4x higher perceived brightness than red lasers used in industrial equipment

Grounded TO56 case configuration compatible with existing preferred driver topologies

ams OSRAM of Premstaetten, Austria has introduced a green laser diode that is said to be a brighter, easier-to-use, more reliable and cost-competitive replacement for red lasers in applications such as levelling, scanning, biosciences and dot projection.

The new PLT5 522EA_Q is an edge-emitting laser with a tightly controlled beam. Its peak output power is 20mW, at a typical peak emission wavelength of 520nm and a spectral bandwidth of 2nm. The laser diode can be used in either continuous-wave or pulsed mode.

The PLT5 522EA_Q for the first time, it is claimed, enables product makers to benefit from the 4x brighter appearance of a green laser compared to red without sacrificing any of the valuable features of red lasers. The green laser diode has been rigorously tested for lifetime and reliability at a maximum operating temperature of 70°C.



Green laser offers 4x higher perceived brightness than red lasers traditionally used in industrial equipment.

Its lifetime ratings are compatible with the standard requirements of industrial equipment manufacturers.

"The much better visibility of green laser beams compared to red means that they are preferred by users in industrial applications such as construction and surveying, and for long-range scanning," says senior marketing manager Thomas Brandes. "The introduction of the PLT5 522EA_Q enables manufacturers to finally replace red lasers with green without compromising on any aspect of their product design."

The new laser diode is housed in a hermetically sealed and grounded TO56 metal can. It is compatible with the driver topologies commonly used with red lasers, and simplifies the use of green lasers, requiring minimal modification of existing product designs.

Unlike a red laser diode, the PLT5 522EA_Q needs no burn-in. It includes a photodiode, which is often required for eye-safe operation.

ams OSRAM offers customers technical support to assist integration into end-product designs. Support includes help with driver integration, optics, thermal evaluation and with application-specific lifetime calculations.

Samples of the PLT5 522EA_Q are available now from any authorized distributor.

www.ams-osram.com

BluGlass completes acquisition of Silicon Valley laser diode fab

Acquisition funded by AUS$3.4m placement to institutional investors

BluGlass Ltd of Silverwater, Australia — which has developed proprietary low-temperature, low-hydrogen remote-plasma chemical vapor deposition (RPCVD) technology for manufacturing devices such as laser diodes, next-generation LEDs and micro-LEDs — has completed its acquisition of a 19,000ft^2 purpose-built commercial laser diode production facility lease and manufacturing equipment in Silicon Valley for US$2.5m (comprising US$2m cash and US$500,000 in new BluGlass shares at an issue price of AUS3.3 cents per share).

BluGlass will now start moving into the facility and preparing its adaption for gallium nitride (GaN) laser diode production — a process expected to take several months. The acquisition should enable BluGlass to accelerate its longer-term growth strategy, bringing key fabrication processes in-house, to improve the quality and consistency of its GaN laser diodes.

"Our newly acquired laser diode fab is game-changing for our growth trajectory. It allows us to significantly scale our manufacturing and revenue generation capacity, improve the quality and repeatability of our laser diodes expected by our customers, and fast-track development timelines for higher-value products at extended wavelengths," says president Jim Haden. "At the same time, it will eliminate supply chain complexity and halve our wafer production costs, paving the way for cash flow break-even," he adds.

"For continuity, we will continue to work with our contract manufacturers over the next year and remain on track to launch our first laser diodes in mid-2022," continues Haden. "The opportunity to acquire a fully operational manufacturing fab, accompanying equipment, and skilled team is incredibly rare, particularly at a time when semiconductor demand is outstripping supply. Our own fab provides the foundation for our future growth and enables us to execute on our strategy to take market share within a high-margin, fast-growing market."

The acquisition was funded by a AUS$3.4m placement to new and existing institutional investors. A non-renounceable 1:4 entitlement offer to raise up to a further AUS$7.5m is underway for the ongoing operation of the production facility, additional CapEx for advanced manufacturing capabilities, and talent hire.

www.bluglass.com.au

BluGlass closes entitlement offer, raising AUS$3.71m

Funds to adapt Silicon Valley fab for GaN laser diode production and ongoing operation

BluGlass has closed its non-renounceable entitlement offer, raising AUS$3.71m before costs. The entitlement offer enabled eligible shareholders to subscribe for new shares on a 1:4 basis at AUS$0.03 per share; and follows a AUS$3.4m placement to US and Australian institutional funds and investors (as announced to ASX on 24 March).

Funds raised will be used to adapt BluGlass' new Silicon Valley manufacturing plant for GaN laser diode production, as well as ongoing operational costs and talent hire.

BluGlass now has a period of three months to place all or part of the rights issue shortfall.

"The ongoing support of our shareholders is an important vote of confidence in our GaN laser diode technology, growth strategy, and new leadership team," says executive chair James Walker. "Our acquisition of a purpose-built laser diode facility enables us to control significant aspects of the supply chain, accelerating our ability to bring new, higher-value products to market while reducing manufacturing overheads. Acquiring an operational laser diode fab at a significant discount to market rates is extremely rare and it caters to our medium- and longer-term needs," he adds.

"We continue our primary focus to solve our reliability challenges and launch our first laser diode products in under-served and in-demand wavelengths," says president Jim Haden. "Our methodical approach to optimizing the four key ingredients (epitaxy, metals, facets and bonds) is already delivering reliability improvements. We look forward to providing prospective customers with sample products," he adds. "Our own fab provides us with the manufacturing and development flexibility to deliver on our value proposition of plug-and-play, easy-to-use laser light. By bringing core competencies in-house, it will enable BluGlass to create best-in-class metals, coatings and bonds to deliver brighter, high-performance better products."

Allotment of all new shares was expected to occur on 21 April with the issue of 123,560,740 fully paid ordinary shares.

Laserline shows first blue diode laser with 3kW CW output

High-power-cladding solution with 45kW IR diode laser developed in cooperation with Fraunhofer IWS

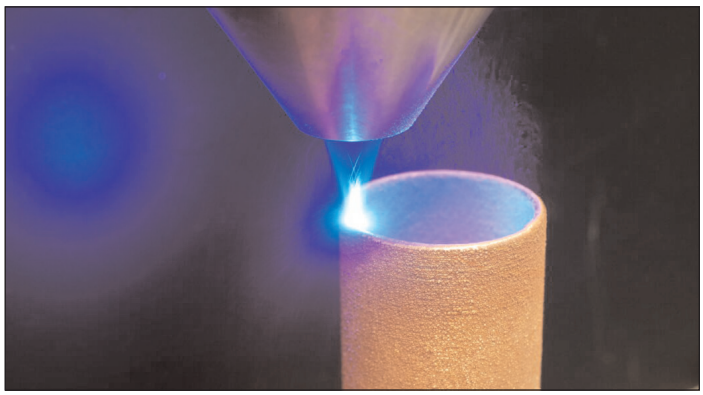
At the Laser World of Photonics 2022 in Munich (26–29 April), Laserline GmbH of Mülheim-Kärlich, Germany, which manufactures diode lasers for industrial material processing, presented what it claims is the first blue diode laser with 3kW CW output power. Designed especially for welding, cladding and additive manufacturing of copper components, the laser is a further milestone in the power development of blue high-power diode lasers.

The second key topic being exhibited is the new high-power-cladding solution based on a 45kW infrared (IR) diode laser, developed in cooperation with the Fraunhofer Institute for Material and Beam Technology (IWS) in Dresden to optimize the industrial cladding of components that are subject to wear and corrosion.

Blue 3kW diode laser for more effective and energy-efficient copper processing

Back in 2019, Laserline had already presented the first blue CW diode laser with 1kW CW output power, whose power was subsequently raised to 2kW just a year later. The blue 3kW diode laser being showcased now exhibits what is said to be the highest performance class of industrial lasers in the blue wavelength spectrum to date.

In line with the 1kW and 2kW Laserline diode lasers, the new laser operates at a wavelength of around 445nm. Compared with infrared radiation, this spectral range is absorbed much better by non-ferrous metals such as copper and gold. Among other benefits, this allows the heat conduction welding of copper components close to the surface, along with more energy-efficient and climate-friendly processes.



Increasing the CW output power to 3kW now enables additional application options. In joining and cladding processes, much faster welds and higher deposition rates can be achieved. In the case of keyhole welding of electrical conductors such as copper hairpins, larger cross-sections can be handled with moderate heat input using blue lasers only. Where hybrid solutions combining blue and infrared lasers continue to be required, less infrared energy is needed today. This clearly optimizes the operation costs and the CO_2 balance of the applications.

Furthermore, the new laser power class enables more efficient additive manufacturing of large and volume-rich copper components. At the Laserline booth, these new application possibilities are being discussed in detail before being demonstrated with the help of different welding and cladding samples.

Cladding with up to 45kW laser power: higher order rates — bigger quantity

The high-power-cladding solution being presented shows the next expansion of a method that was established by Fraunhofer IWS using the Laserline IR diode laser with output power of 20kW. In some cases it even exceeds the application rates in PTA (plasma transferred arc) cladding.

Being the first process of its kind, it enables wear- and corrosion-protection coatings for large components such as power plant elements, brake discs, hydraulic cylinders or plain bearings to be readily implemented for series production and in a cost-effective manner. Access to the use of a higher diode laser power class with up to 45kW output power further increases the efficiency and productivity of the process. This enables higher order rates and larger quantities at reduced process costs.

www.laserline.com/de-int

TRUMPF presents new generation of 940nm single-mode and multi-mode VCSELs

New VCSEL solutions for proximity sensing, laser auto-focus and under OLED display sensing

TRUMPF Photonic Components GmbH of Ulm, Germany (part of the TRUMPF Group) — which manufactures vertical-cavity surface-emitting lasers (VCSELs) and photodiodes for the consumer electronics, datacoms, industrial sensing, heating and automotive markets — is presenting new VCSEL solutions to expand its portfolio for 3D sensing in consumer and industrial applications.

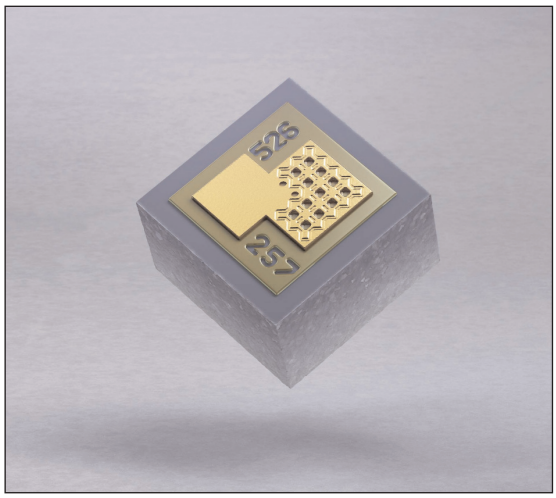
The new-generation 940nm VCSEL arrays enable improvements in various functionalities combined with high reliability performance such as long product lifetime at a broad temperature range. The new VCSEL generation therefore leads to better results in optical applications such as proximity sensing, laser auto-focus applications or under organic light-emitting diode (OLED) display sensing.

TRUMPF also addresses the trend of all-screen-display in high-end consumer electronics, and the challenge of system designers to place advanced optical sensing technologies beneath the displays. Furthermore, the new generation is a suitable light source for advanced industrial and automotive time-of-flight (ToF) applications.

"It was back in 2015 when the first TRUMPF VCSEL, and the first VCSEL at all, was put into a smartphone for proximity sensing," says Ralph Gudde, VP marketing & sales. "Our innovation leadership is substantiated by over 1.6 billion VCSELs shipped out since then, to enable 3D sensing and illumination in smartphones."

Improvements in sensing and illumination quality

To enhance the quality in proximity sensing and laser auto-focus applications, the new single-mode 940nm VCSEL array consists of 12 quadratic emission zones to generate a high output power of 18mW. Optical application design becomes significantly easier thanks to the absolutely symmetrical and Gaussian-shaped beam profile, TRUMPF says. The device performance remains single-mode even when operated at nanosecond pulses, and stable output power performance over lifetime is ensured by the robust design.



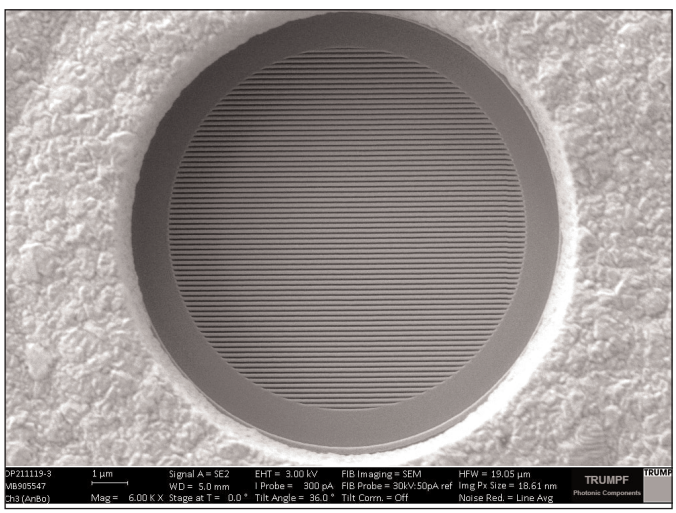
New generation of 940nm-emitting VCSEL array with 12 emitters for high optical output power to enhance the quality in proximity sensing and laser auto-focus applications.

A second new product (to be launched soon) is a multi-mode VCSEL that comes with controllable polarization. The feature of stable and advanced linear polarization improves the illumination quality and resolution in demanding 3D illumination applications such as optical sensing through OLED displays. This new multi-mode 940nm VCSEL comes with two emission zones that generate an optical power of 8mW. TRUMPF has developed the patented technology of VCSELs with stable polarization for high-volume applications. The polarization is locked by a surface grating etched directly into the gallium arsenide (GaAs). Due to the optimized grating design the new polarized VCSELs achieve almost 100% of the efficiency compared with standard non-polarized VCSELs.

"With our expanded portfolio of single- and multi-mode, high-power and polarization-controlled VCSEL products, we are well positioned to serve the demanding 3D sensing and illumination applications not only in smartphones but also in virtual-reality (VR) and augmented-reality (AR) as well as industrial and automotive applications," reckons Gudde.

TRUMPF Photonic Components exhibited at LASER World of Photonics 2022 in Munich, Germany (26–29 April).

www.trumpf.com/s/VCSEL-solutions



Polarization is locked by a surface grating etched directly into the GaAs. Polarization improves the illumination quality and resolution in demanding 3D illumination applications.

TRUMPF presents VCSEL heating systems for faster and better flip-chip assembly

Laser-assisted bonding and soldering improve on reflow

At LASER World of Photonics 2022 in Munich, Germany (26–29 April), TRUMPF Photonic Components presented new processes utilizing its VCSEL heating systems for flip-chip assemblies in the electronics industry.

By using VCSEL heating systems for laser-assisted bonding (LAB) and laser-assisted soldering (LAS), cycle times are reduced to a ninth compared with standard reflow soldering processes. Furthermore, the quality and reliability of PCB assemblies are increased, since the VCSEL heating systems work with high precision. As the intensity distribution of laser radiation can be adjusted through individual control of single laser zones, the heat is only applied on the PCB and semiconductor die where it is needed. Consequently, the quality and lifetime of the PCB boards as well as the die attach and solder interfaces benefit because warpage and heat within the die are significantly reduced.

The assembly process also benefits from very repeatable and accurate die bonding and soldering conditions, as the VCSEL heating system allows homogenous illumination, fast switching times and precise power control.

Another aspect is the overall footprint for microchip assembly, which can be reduced compared with conventional reflow solutions because the VCSEL heating systems are very compact.

Laser-assisted soldering and laser-assisted bonding

In laser-assisted soldering (LAS), the solder balls are soldered directly on the PCB using VCSEL infrared heat treatment. This is particularly of relevance to supporting the trend towards using smaller solder balls and pitches, which in turn also allows for a reduction in overall space needed in consumer electronics.

In laser-assisted bonding (LAB), a flip-chip is placed on a PCB board using solder balls as a connection. The VCSEL system heats the chip from above, and the laser energy is transmitted through a silicon die to melt the solder balls between the chip and PCB. VCSEL heating systems can be used either for stationary heating or for on-the-fly heating applications. The VCSEL-based systems offer bigger heating areas with higher power compared with other solutions.

In its Customer Application Center in Aachen, Germany, TRUMPF offers customers a testing lab for these potential applications. "With our unique VCSEL heating modules, electronics manufacturing can also benefit," says Ralph Gudde, VP marketing & sales at TRUMPF Photonic Components. "The compact design and its homogeneous heating patterns lead to better process control and higher product quality. At the same time, it reduces the footprint of the assembly production line — in the case of LAB of up to 30%."

www.world-of-photonics.com/en
www.trumpf.com

LEED Silver certification for Lumentum's San Jose HQ

Lumentum Holdings Inc (which designs and makes photonics products for optical networks and lasers for industrial and consumer markets) has achieved LEED (Leadership in Energy and Environmental Design) Silver certification for its headquarters building in San Jose, CA, USA.

Developed by the US Green Building Council (USGBC), LEED is the most widely used rating system and a recognized international symbol of sustainability achievement. Compared with traditional construction, LEED-certified buildings, through design, construction and operation practices that improve environmental and human health, have 34% lower CO_2 emissions, consume 25% less energy and 11% less water, and have diverted more than 80 million tons of waste from landfills.

"Achieving LEED certification is more than just implementing sustainable practices. It represents a commitment to making the world a better place and influencing others to do better," says USGBC's president & CEO Peter Templeton. "Given the extraordinary importance of climate protection and the central role buildings play in that effort, Lumentum is creating a path forward through their LEED certification," he adds.

"In 2021, we announced 100% renewable electricity at our headquarters, and LEED certification is another step forward in the company's commitment to achieving net-zero carbon emissions by 2030," says Mehdi Golshan, Lumentum's senior director of Workplace Services.

Lumentum achieved LEED certification for implementing measurable strategies to ensure that its building is operating at a high level of sustainability. The company applied practical solutions to several areas in the building, including implementing energy-efficient systems, reducing environmental impact through the adoption of green cleaning and pest management, installing efficient water management devices, and improving the indoor air quality by installing enhanced filtration systems.

www.usgbc.org
www.lumentum.com

Lumentum and Ambarella unveil joint reference design combining edge AI and privacy for smarter building automation and occupancy sensor systems

Flood illuminator module for ToF 3D sensing combined with edge AI SoC

Lumentum Holdings Inc of San Jose, CA, USA (which designs and makes photonics products for optical networks and lasers for industrial and consumer markets) and edge artificial intelligence (AI) vision semiconductor and software company Ambarella Inc of Santa Clara, CA, have announced a new joint reference design that combines edge artificial intelligence (AI) with privacy, enabling new possibilities for smart building applications. Called Vision-D and available now, the design combines Lumentum's flood illuminator module for extremely accurate time-of-flight (ToF) 3D sensing with Ambarella's CV22 edge AI SoC (system-on-chip). This combination allows small AIoT sensors with local processing to be blanketed across buildings for applications such as occupancy monitoring, intelligent space management and smart retail. Additionally, ToF 3D sensing maintains privacy by generating a point cloud with granular 3D information, but without any personally identifiable information, for applications such as healthcare and eldercare.

According to MarketsandMarkets, the occupancy sensor market will rise at a compound annual growth rate (CAGR) of 13.3% from $1.9bn in 2020 to $3.6bn by 2025. The vast majority of these systems are based on passive infrared sensors (PIRs) that provide only basic information about occupants and the building environment, while a small number are using cameras that capture identifiable features.

The new joint reference design is reckoned to open up possibilities for adding intelligent sensing with AI processing smarts at the edge, while offering privacy and avoiding the high cost of cloud computing. Integrating intelligence directly onto these sensing nodes allows functionality and scalability, such as the creation of digital twins for automated real-time space utilization or hot desking in shared workspaces. Other applications include traffic-based hospitality staffing, cleaning and maintenance alerts to address the labor shortage, and maximized energy efficiency through the fine-tuned usage of HVAC and lighting systems.

Lumentum's flood illuminator module for extremely accurate time-of-flight (ToF) 3D sensing.

"There are currently two choices for occupancy sensing in building automation systems — basic motion-detection devices that preserve privacy, or intelligent camera-based systems that compromise privacy," says Jerome Gigot, senior director of marketing at Ambarella. "This joint reference design combines Lumentum's high-performance flood illuminator module with our CVflow edge AI SoC to provide a novel solution for digital transformation that protects occupant privacy," he adds.

"The use of sophisticated building automation and occupant monitoring solutions is expanding rapidly, driven by home healthcare and monitoring for the world's growing senior population, efficient building usage with hybrid work schedules, and other increasingly important applications," says Ken Huang, director of product line management at Lumentum. "This innovative reference design uniquely addresses key requirements of building automation and occupant monitoring systems by providing rich data sets and processing power while being unobtrusive in terms of both size and privacy."

In addition to supporting multiple image sensor inputs, Ambarella's CV22 SoC also offers a rich set of peripheral interfaces for a broad range of other sensors — including humidity, temperature and audio — to enhance environmental perception. The Lumentum 10W flood illuminator module incorporates a high-performance, three-junction vertical-cavity surface-emitting laser (VCSEL) array for ToF 3D sensing.

The Vision-D reference design provides a versatile platform for a wide range of applications in smart building automation, healthcare, smart retail and home security. Examples include smart PIRs for home security that are able to differentiate pets from intruders; hotel environmental and scheduling systems that can intelligently adjust the HVAC temperature in reserved rooms based on real-time occupancy; and remote monitoring of aging parents without invading their privacy. Regardless of the location, AI algorithms running on this reference design can monitor occupants for sudden falls or medical events, intelligently and immediately triggering a request for emergency services.

Customers can also leverage the broad set of tools and ecosystem partners from both companies to further accelerate their time to market.

www.ambarella.com
www.lumentum.com/en/products/10-w-flood-illuminator-module

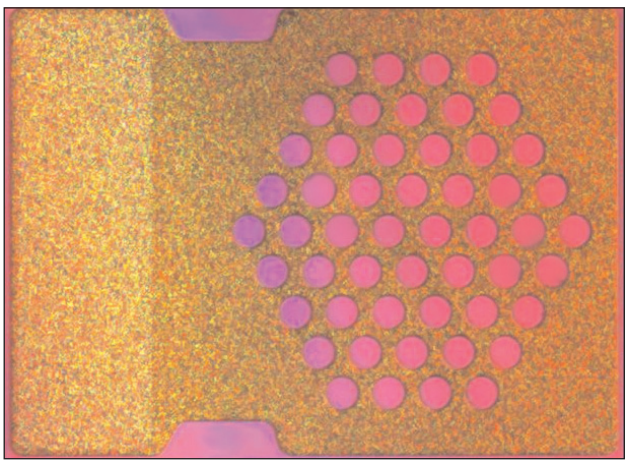
Lumentum launches series of multi-junction 905nm VCSEL arrays for advanced mobility and industrial applications

First 70W product to be followed later in second-quarter 2022 by 100W and 400W products

Lumentum Holdings Inc of San Jose, CA, USA (which designs and makes photonics products for optical networks and lasers for industrial and consumer markets) has announced the M Series of multi-junction vertical-cavity surface-emitting laser (VCSEL) arrays for next-generation automotive, industrial light detection & ranging (LiDAR) and 3D sensing applications, and availability of the first M Series product, the M51-100 905nm 70W multi-junction VCSEL array.

Lumentum's automotive-qualified, high-performance M Series features peak powers suited for short- and long-range advanced mobility and industrial LiDAR applications. In addition to higher available power densities, extensive accelerated life testing of the multi-junction M Series has shown the same high reliability as single-junction VCSEL devices already in volume production. The firm says that the M Series is easily integrated into customer platforms and can replace edge-emitting lasers in existing mechanically scanned systems or arrayed into configurable illumination sources for addressable, solid-state electronic scanning LiDAR systems. VCSELs provide advantages in efficiency, scalability and reliability that are essential to the accelerating rate of innovation in automotive and industrial LiDAR and 3D sensing applications, adds the company.

"The Lumentum M Series enables automotive and industrial customers to accelerate the development of next-generation LiDAR systems," says Alex Ju, product line manager for 3D sensing. "The M51-100, with its extremely small size, is a versatile solution applicable to a wide range of customer systems," he adds.



Lumentum's M51-100 905nm 70W multi-junction VCSEL array.

"We are continuing to build upon our leadership in multi-junction technology that we have developed over the past several years," says Matt Peters, senior director of R&D for 3D sensing. "The new M Series products provide customers with highly differentiated performance and reliability in devices that address a wide range of LiDAR system architectures."

LiDAR and 3D sensing are increasingly used in advanced mobility and industrial applications. Automotive LiDAR enables autonomy at multiple levels, from advanced adaptive cruise control (ACC) capabilities to fully autonomous vehicles (AVs). In-cabin driver and occupant monitoring systems are becoming standard parts of vehicle safety systems and are continuously improving and adding new features, such as biometric recognition. In addition, LiDAR is advancing factory automation and being used to optimize performance, safety and cost in industrial environments, including autonomous mobile robots, automated guided vehicles (AGVs), and last-mile delivery vehicles.

Lumentum's automotive-qualified, high-performance M Series features peak powers suited for short- and long-range advanced mobility and industrial LiDAR applications

The M51-100 905nm 70W multi-junction VCSEL array is a compact, highly reliable, power-dense solution optimized for next-generation LiDAR systems. The product is the first of Lumentum's high-performance M Series, which features flexibility across size, form factor and peak power to suit short- and long-range LiDAR applications. AEC-Q102 qualified, the M51-100 leverages proven high-volume production and is easily integrated into customer automotive and industrial platforms, says Lumentum. With high power output and a 0.19mm^2 chip size, the M51-100 is an adaptable solution that can replace edge-emitting lasers in existing mechanical solutions or arrayed into configurable illumination sources for addressable, solid-state electronic scanning LiDAR systems.

Further M Series product releases are expected later in second-quarter 2022. The M52-100 is a 100W multi-junction VCSEL array designed for line-scanning LiDAR solutions, and the M53-100 is a 400W device tailored for flash LiDAR systems with unprecedented power from a VCSEL product.

www.lumentum.com/en/products/70-w-905-nm-multi-junction-vcsel-array

Alter Technology opens Photonics Design Centre at University of Strathclyde

Centre to accelerate commercialization of photonic products for quantum technology and space markets

As part of TÜV NORD Group (one of Germany's largest technical service providers), Alter Technology TÜV NORD — which provides micro- and optoelectronics services in engineering, procurement, assembly and test for the space and harsh-environment sectors — has opened a Photonics Design Centre in Glasgow, Scotland, at the University of Strathclyde, to accelerate the commercialization of photonic products into quantum technology and space markets.

Based in Strathclyde's Technology & Innovation Centre (TIC) in Glasgow City Innovation District, the centre will support Alter Technology Group's development of highly integrated, miniaturized and robust photonic products to be used in quantum-enabled positioning, navigation and timing systems and photonic-based satellite optical communications.

Over the next 3–5 years, the group will allocate about €6m to the Design Centre and its UK manufacturing site in Livingston, West Lothian, to fund equipment, facilities, personnel and other R&D costs.

Its existing manufacturing site will also benefit from additional investment in associated robotic-based manufacturing equipment and processes for photonic products.

The centre's engineering team is already working on projects and customer requests, and expects to move into its new Glasgow facility in May. The Fraunhofer Centre for Applied Photonics (CAP) and Strathclyde's Institute of Photonics — key partners for Alter Technology — are based within the same building, with the Physics Department teams nearby.

The opening of the new centre complements the current global manufacturing, test, qualification and sales operations of the group.

Alter Technology TUV Nord's business development manager Una Marvet and CEO Stephen Duffy, University of Strathclyde principal professor Sir Jim McDonald, Simon Andrews, chief executive of the Fraunhofer.

"I am delighted that Alter Technology has chosen to open its new Photonics Design Centre within the TIC building in Glasgow City Innovation District," says professor Sir Jim McDonald, principal & vice-chancellor of Strathclyde. "Our Department of Physics has an internationally leading capability in Photonics and Quantum Optics, and was ranked first in the UK for Physics research in the Times Higher Education's analysis of the last national research assessment exercise — with 93% of its submissions rated as world-leading," he adds. "As a key and valued partner of the university, Alter Technology's co-location with the Fraunhofer CAP, our own Institute of Photonics and the Department of Physics will provide many benefits for the company and be a real boost to the Scottish Photonics industry, the wider Scottish academic sector and the growing innovation ecosystem in Glasgow."

Partnerships

"There were a number of factors that played an important role in convincing us to select the Technology and Innovation Centre as the location for our Photonic Design Centre," says Alter Technology TUV Nord UK's CEO Stephen Duffy. "The key reasons were the importance of the local photonics and quantum eco-system, access to skills, and proximity to our key partners at Fraunhofer UK and the research, innovation and leadership in quantum technology that takes place in the Physics Department at Strathclyde."

A Quantum Technology Cluster is embedded in the Glasgow City Innovation District (CGID), an initiative driven by Strathclyde along with Glasgow City Council, Scottish Enterprise, Entrepreneurial Scotland and Glasgow Chamber of Commerce. GCID is envisaged as a global place for quantum industrialization, attracting companies to co-locate, accelerate growth, improve productivity and access research technology and talent at Strathclyde. To date, Strathclyde has invested more than £110m in its Technology and Innovation Zone, which has become the heart of the District.

Strathclyde is the only academic institution that has been a partner in all four Engineering and Physical Sciences Research Council (EPSRC)-funded Quantum Technology Hubs in both phases of funding, in: Sensing and Timing; Quantum Enhanced Imaging; Quantum Computing and Simulation, and, Quantum Communications Technologies.

www.altertechnology-group.com
www.cap.fraunhofer.co.uk
www.strath.ac.uk/science/physics/instituteofphotonics

Vector Photonics' CTO completes RAE's Shott Scale Up Accelerator program for technology entrepreneurs

Richard Taylor gains IoD Certificate in Company Direction

Photonic-crystal surface-emitting laser (PCSEL) firm Vector Photonics Ltd of Glasgow, Scotland, UK says that its chief technology officer Dr Richard Taylor has completed the Royal Academy of Engineering's Shott Scale Up Accelerator program.

As an entrepreneur, Ian Shott CBE FREng helped to establish the RAE's Enterprise Hub in 2013 to give entrepreneurial engineers the skills to scale up their businesses and succeed.

Managed by the Enterprise Hub, the Shott Scale Up Accelerator program seeks to equip young, engineering-based leaders and founders of high-growth UK technology companies with the skills they need for growth. Applicants compete for places on the program. The winners receive a £10,000 grant towards training, expert business mentoring and coaching — all aimed at developing a leadership mindset, strategic capability, and business-growth skills.

Vector Photonics' chief technology officer Dr Richard Taylor.

"Managing the effective scaling of a technology company is as critical to its success as having the original idea. Many businesses struggle or fail at this point," says Taylor. "The RAE's Shott Scale Up Accelerator program has given me the skills I need to help grow Vector Photonics, alongside the other directors. I used the £10,000 training grant for the IoD (Institute of Directors) Certificate in Company Direction, covering the role of a board director, finance for non-FDs, strategy, and leadership," he adds. "I have also become part of a community of talented and proven engineers and innovators, including Enterprise Hub members and Fellows of the Academy. Not only do they have a wealth of business experience, but they also offer support and willingly share their invaluable expertise."

Vector Photonics' lasers on schedule with project BLOODLINE

High-power 1030nm PCSELs being developed for 3D metal printing

In advance of the LASER World of PHOTONICS 2022 trade fair in Munich, Germany (26–29 April), Vector Photonics said that the project BLOODLINE (Bright Laser diOdes fOr aDvance metaL addItive maNufacturing systEms) is on schedule.

Funded by UK Government agency Innovate UK (which provides funding and support for business innovation as part of UK Research and Innovation) and led by Vector Photonics, the £1.5m BLOODLINE project is developing high-power 1030nm PCSELs for next-generation 3D metal printing.

The project is guided by the Eureka Network international development program, in conjunction with Innovate UK's Japanese counterpart, the Japan National Research and Development Agency's New Energy and Industrial Technology Development Organization (NEDO).

Japan-based laser epitaxy manufacturer QD Laser Inc (a spin-off from Fujitsu Laboratories Ltd) has partnered Vector Photonics for wafer supply. A group of industrial equipment manufacturers will provide product assessment. The UK's Compound Semiconductor Applications (CSA) Catapult will provide independent accelerated life testing (ALT).

The project is guided by the Eureka Network international development program, in conjunction with Innovate UK's Japanese counterpart, NEDO

"Vector Photonics' high-power PCSELs are set to revolutionize the 3D metal printing industry," reckons Vector's chief technology officer Dr Richard Taylor. "They significantly increase printer performance and could well accelerate market growth, which is already set to quadruple to $10bn by 2025 [according to the report 'Additive Manufacturing with Metal Powders, 2019' from SmarTech Analysis]," he adds. "The PCSELs have a unique combination of increased power; reduced cost and improved performance – the result of higher resolution and faster printing, along with reduced finishing overheads."

www.world-of-photonics.com/en
www.vectorphotonics.co.uk

II-VI's 940nm VCSEL flood illuminator modules compliant with AEC-Q102 for automotive in-cabin use

Higher optical power with narrower spectral width than infrared LEDs in existing driver monitoring systems

Engineered materials and optoelectronic component maker II-VI Inc of Saxonburg, PA, USA, which provides depth sensing technology, says that its 940nm vertical-cavity surface-emitting laser (VCSEL) flood illuminator modules have been qualified to the Automotive Electronics Council's AEC-Q102 quality standard for automotive in-cabin applications.

US and European transportation safety regulators are increasingly recommending or requiring driver and occupancy monitoring systems in vehicles, fueling the demand for next-generation 2D and 3D infrared cameras designed with higher-performance infrared illuminators. II-VI says that its new VCSEL flood illuminator modules emit higher optical power with a narrower spectral width than infrared LEDs currently used in existing driver monitoring systems, enabling substantial improvements in 2D imaging performance. The infrared light emitted from II-VI's flood illuminator modules can be modulated to frequencies greater than 100MHz, making them suitable for high-resolution 3D time-of-flight (ToF) cameras for driver and occupancy monitoring systems.

"Our new VCSEL flood illumination modules meet the stringent quality requirements of automotive applications and offer great value to our customers through our vertical integration of VCSEL chips, photodiodes and diffuser optics," says Dr Julie Sheridan Eng, senior VP, Optoelectronic Devices & Modules business unit. "We are also leveraging our in-house, 6-inch, gallium arsenide semiconductor laser technology platform to achieve economies of scale."

The infrared light emitted from II-VI's flood illuminator modules can be modulated to frequencies greater than 100MHz, making them suitable for high-resolution 3D ToF cameras for driver and occupancy monitoring systems

II-VI says that its VCSELs and flood modules achieve a very high power-conversion efficiency and are available in surface-mount packages integrated with diffuser optics with either a narrow (60°x45°) or wide (140°x110°) field of view. The modules operate over the wide temperature range of –40°C to 105°C.

II-VI's portfolio of products for sensing includes infrared VCSEL chips with one or up to hundreds of elements. The firm also offers thin-film filters and diffractive optical elements (DOEs), including lenses, microlens arrays, diffusers and splitters, that are produced at wafer scale for high-volume applications.

www.ii-vi.com

II-VI signs renewable energy contracts for nine sites in US

Firm now purchasing 30% of electricity from renewable sources

Engineered materials and optoelectronic component maker II-VI Inc of Saxonburg, PA, USA says that it has signed renewable energy contracts for powering nine of its sites in the USA with 100% renewable electricity. The sites range from some of II-VI's most advanced manufacturing sites and some small engineering offices to multiple facilities across the USA in California, Oregon, New Jersey and New York.

The latest agreements represent 20 million kWh of renewable electricity per year, avoiding an additional 5000 metric tons of CO_2 emissions annually.

II-VI had already announced in October 2021 that it is powering all of its facilities in Europe with 100% renewable electricity sources, and in January that its largest plant in China would be powered with 100% renewable electricity sources within four years.

II-VI has set reducing its carbon footprint across its global operations as a top priority. The firm has now entered into renewable electricity contracts for over 30 sites around the world, including more than two dozen that now cover 100% of its annual electricity usage with renewable sources.

"With these agreements, we now purchase approximately 30% of our electricity from renewable sources," says Gary Kapusta, chief shared services & supply chain officer. "We expect to continue to increase our renewable energy purchases every year, and we are delighted to make this announcement in conjunction with International Mother Earth Day as part of our commitment to increase the sustainability in our energy supply across our global footprint."

www.ii-vi.com

Windstream Wholesale completes first 400G ZR+ interoperability trials, using II-VI and Acacia modules

Windstream becomes first service provider member of OpenZR+ MSA

Optical solutions provider Windstream Wholesale of Little Rock, AK, USA has tested the interoperability of QSFP-DD form factor ZR+ pluggable modules from II-VI Inc of Saxonburg, PA, (which provides optical communications solutions for datacom and telecom networks) and Acacia Communications Inc of Maynard, MA (now part of Cisco), which makes high-speed coherent optical interconnect products. The tests established 400 Gigabit links in a production environment over a 1027km link. The team also leveraged the Marvell Deneb coherent DSP (digital signal processor) within a native 0dBm II-VI pluggable and the Acacia module using the Greylock DSP. Industry-standard oFEC (open forward-error correction) algorithms were also used in the trials.

"These successful trials demonstrate that Windstream Wholesale remains the optical technology leader in making 400G wavelengths the default deployment for large wholesale and hyperscale customers," claims Buddy Bayer, president of Enterprise and Wholesale at Windstream. "Interoperability is key to simplifying high-performance networks in a cost- and energy-efficient manner, and no other service provider has done more than Windstream toward making it a reality in the marketplace," he adds. "This significant achievement validates Windstream's strategy of open, disaggregated optical networking."

Windstream has also become the first service provider member of the OpenZR+ MSA (multi-source agreement). "We see the OpenZR+ community as well positioned to make progress around standardization and interoperability in the high-performance transceiver arena," says Art Nichols, VP of network architecture and technology. "Our goal is not simply to take advantage of our interop and optimization learnings internally, but to also contribute to the industry as a whole in driving open networking forward," he adds.

"The success of these trials validates the level of maturity of the 400G ZR+ ecosystem, which is essential to enable open systems and network architectures such as IP-over-DWDM," comments Matthias Berger, VP, coherent technology, II-VI Inc.

"As one of the founding members of the OpenZR+ MSA, we are excited to see the industry embracing interoperability and moving towards open networking architectures," says Tom Williams, senior director of marketing for Acacia and co-chair of the OpenZR+ MSA. "Interoperability and the introduction of new modules, such as our recently announced Bright 400ZR+ QSFP-DD pluggable, will be key to accelerating the adoption of router-based optics in transport networks," he adds.

"The Marvell Deneb Coherent DSP has enabled a large open ecosystem of suppliers to drive rapid adoption of OpenZR+ in carrier and cloud networks," claims Samuel Liu, Marvell's senior director of product marketing.

Windstream's Intelligent Converged Optical Network provides open and disaggregated networking infrastructure, enabling wholesale and enterprise technology customers to select unique custom routes, maintain operational insights with Windstream's Network Intelligence functions, and place their networks closer to the edge to better serve end-users.

www.ii-vi.com
www.acacia-inc.com
www.windstreamwholesale.com

II-VI renews annual pledge of $1m to fund STEM educational and research programs

In 2022, second consecutive year, II-VI Inc is contributing $1m in unrestricted funds to support the goals of the II-VI Foundation, whose mission is to encourage and enable students to pursue careers in science, technology, engineering and mathematics (STEM) while maintaining a standard of excellence in that pursuit. The private foundation's two primary programs are block gifts for graduate students and undergraduate student scholarships.

"Our renewed pledge to the II-VI Foundation is one of the pillars of our ESG [environmental, social and governance] initiatives that aims to support STEM education where it is most needed and helps build a future generation of diverse leaders in our field," says chair & CEO Dr Vincent D. Mattera Jr. "We are proud of our close ties with the II-VI Foundation, through its co-founder and II-VI co-founder Dr Carl J. Johnson," Mattera adds.

Since 2007, the II-VI Foundation has awarded over $30.6m to STEM students in the form of scholarships, block-gift funding for research projects and mini conferences, along with early education initiatives and postdoctoral fellowships. Over 16,700 students have been impacted by the programs, with 71 Ph.D. degrees and 42 M.S. degrees awarded to students participating in Foundation-supported research at 46 institutions of higher learning.

www.ii-vi.com

EU-funded project INSPIRE combining SiN and InP PICs with wafer-scale micro-transfer printing

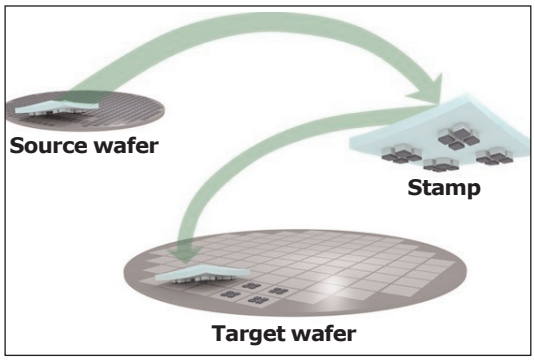
Hybrid photonic integrated circuits to enable high-throughput manufacturing for applications beyond communications

After receiving nearly €5m in funding from the European Union's Horizon 2020 research and innovation program (under grant 101017088), the project INSPIRE was officially launched on 1 January.

Coordinated by Technical University of Eindhoven (TU/e) in the Netherlands and including imec, Thales, University of Cambridge, X-Celeprint, SMART Photonics, and Amires, the INSPIRE project consortium aims to change how photonic integrated circuit (PIC) devices are fabricated in order to make them suitable for applications beyond communications (such as healthcare or sensing) and to speed up their large-scale production (overcoming existing limitations on scalability and high-throughput manufacturing).

In recent years there has been an upsurge in the use of photonic devices, based on materials including silicon, silicon nitride (SiN) and indium phosphide (InP), particularly for data transfer applications, notes TU/e. While these devices have the potential for wider impact in other fields like sensors used in aircraft or communication devices, their uptake is limited since different materials need to be effectively combined to meet performance requirements.

For example, high-performance fiber sensors used in infrastructure monitoring and microwave signal processing in radar systems require both low-noise operation and ultra-low degradation of signals. This can only be achieved through a combination of materials in the manufacturing process. If this manufacturing process can be properly scaled to allow large-scale production, it is expected that these photonic devices can have a major impact on sensing applications.



To facilitate the combination of these high-performance III-V optoelectronic materials in photonic devices, INSPIRE is developing wafer-scale micro-transfer printing technologies.

In micro-transfer printing, devices are first made on a source wafer, then transferred to a target wafer (see image). This printing concept has been established and widely applied by project partner X-Celeprint to different wafers and materials. The INSPIRE project is focusing on the next step: parallel device printing with accurate placement where many integrated devices can be printed at the same time.

The INSPIRE micro-transfer printing technology will be validated for three specific cases: fiber sensors to measure stress, strain and temperature for use in airplane safety measures; a microwave photonic radio frequency (RF) pulse generator with application in radar and wireless communication; and optical switches for energy-efficient data centers. Compact versions of the III-V optoelectronic components will be developed, enabling designers to use this platform for a wide range of applications.

Combining established fabrication technologies

INSPIRE aims to consolidate established fabrication approaches, such as those from pure-play foundry and TU/e spinoff SMART Photonics and the silicon photonics pioneer imec, with the micro-transfer printing technology of X-Celeprint. This should result in a world-first fabrication platform that combines the strengths of two of the most well-known PIC manufacturing platforms. Methods will chiefly be developed for the coupling of SiN and InP processes, but could also be used for silicon-based photonics.

"By combining SMART and imec technologies, with only minor changes to the fabrication processes, we can leverage the major investments in the development of these platforms from the last decade," says INSPIRE coordinator professor Martijn Heck of Eindhoven University of Technology. "We can thus significantly reduce the time needed to transfer our technology out of the lab, and make a faster and telling impact in new application areas," he reckons.

Applications

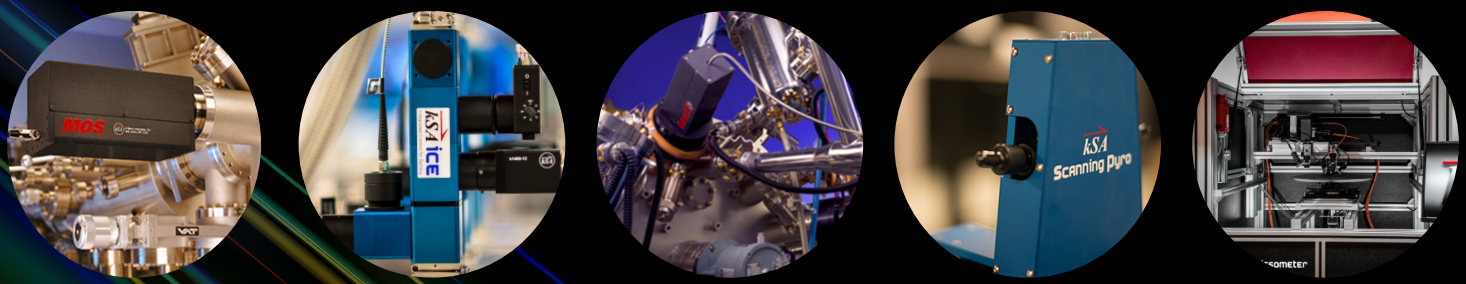
The potential of the INSPIRE approach is demonstrated by the participation of industrial partners such as Dr Jerome Bourderionnet of THALES: "The INSPIRE platform enables high-performance building blocks, such as low-linewidth lasers, which are at the heart of THALES' applications for optical signal processing at large, or sensing integrated systems," he says.

INSPIRE aims to create a full-function PIC platform, compatible with open-access pilot manufacturing, and with an order-of-magnitude lower cost for volume production.

The INSPIRE consortium says that its generic approach makes the technology widely applicable and ensures that European innovators can focus their R&D directly on manufacturing platforms. As a result, it should take a shorter time to bring these PIC technologies to market.

www.tue.nl

When Accurate Real-Time Measurement Matters



In Situ Thin-Film Metrology Solutions for Research, Development, and Production

- Film thickness and deposition rate
- Wafer and film temperature
- Thin-film stress and strain
- Wafer curvature, bow, and tilt
- Surface roughness and quality
- Wafer carrier characterization
- Analytical RHEED

Visit www.k-space.com today to discover the measurement solution that's right for you.

k-Space Associates, Inc.
Putting Light to Work
www.k-space.com

POET joins SHINE Center for photonics integration as founding member

Singapore Hybrid-Integrated Next generation micro-Electronics center to develop material-to-circuit solutions for multi-chip integrated systems

POET Technologies Inc of Toronto, Ontario, Canada — designer and developer of the POET Optical Interposer and photonic integrated circuits (PICs) for the data-center and telecom markets — has joined the Singapore Hybrid-Integrated Next generation micro-Electronics (SHINE) Center, located in the College of Design and Engineering at the National University of Singapore (NUS), as a founding member.

"The vision for SHINE comes from professor Aaron Thean, dean of the College of Design and Engineering, with whom POET has worked for a number of years on certain engineering challenges, and more recently professor Lim Yeow Kheng, who joined the faculty about two years ago from STATS ChipPAC Pte Ltd," says POET's chairman & CEO Dr Suresh Venkatesan. "SHINE brings together equipment and expertise that NUS and companies in the consortium may use, independently and confidentially, to develop advanced processes and manufacturing techniques for hybrid integration of photonics devices," he adds. "The systems, scientific instruments and engineering staff at NUS complements well our existing operation in Singapore, especially in the area of 2.5D and 3D semiconductor manufacturing. We plan to use the SHINE Center to design and manufacture Optical Interposer-based solutions for several new vertical markets, consistent with the mission of SHINE, including applications in sensing and the Internet of Things (IoT)."

The mission of the SHINE Center is to address fundamental issues arising in IoT microelectronics and to engage industry players during the development cycle, to eventually translate the technology to industry. A team formed by professors across the world from NUS, Singapore's Nanyang Technological University (NTU), University of California Berkeley (UCB) and Northeastern University in the USA, the Institute of Microelectronics (IME) at Singapore's Agency for Science, Technology and Research (A*STAR) and Singapore's DSO National Laboratories (DSO) will be actively involved as research participants. Other members of the consortium include Advanced Micro Foundry (AMF), Applied Materials, Cadence Design System, Continental Automotive and SOITEC. James Lee, VP & general manager of POET's Singapore subsidiary, has played a key role in the conception of the consortium and will lead several projects on behalf of the firm. SHINE is expected to have a partnership launch and inaugural technical workshop in June.

As a National Research Foundation-Future Systems & Technology Directorate (NRF-FSTD)-funded heterogeneous integration R&D center, working with A*STAR, SHINE aims to develop disruptive material-to-circuit solutions for multi-chip integrated systems. The research center is focused on developing a process and design platform that bridges across multiple size scales; from chip to large-area substrates. Such innovations should translate to new IoT applications and associated technologies like wearables, smart vehicles, and space technologies.

https://cde.nus.edu.sg/research/research-centres/singapore-hybrid-integrated-next-generation-electronics-shine-centre-shine

Sivers Photonics showcases InP100 product platform

4" InP manufacturing platform enabling acceleration of silicon photonics

Sivers Semiconductors AB of Kista, Sweden (which supplies chips and integrated modules) says that its subsidiary Sivers Photonics of Glasgow, Scotland, UK exhibited and spoke at the Optical Fiber Communication Conference and Exhibition (OFC 2022) in San Diego, CA, USA (6–10 March).

In the firm's booth, the Sivers Photonics team of technical experts discussed the InP100 product platform, a common design and manufacturing framework that uses established process modules to produce a broad range of active III-V photonic devices, including high-power distributed feedback (DFB) lasers and reflective semiconductor optical amplifier (SOA) chips.

"This advanced 4" indium phosphide manufacturing platform is enabling the acceleration of silicon photonics (SiPh) for a wide variety of high-volume, low-cost applications, including data center, artificial intelligence (AI) and optical sensing," says Sivers Photonics' managing director Billy McLaughlin.

Also, chief technology officer Dr Andy McKee took part in the panel session 'Progress and Roadmap in Silicon Photonics Foundries and Supply Chains', discussing how commercial foundry services and supply chain enablement are playing a critical role in the silicon photonics ecosystem.

www.sivers-semiconductors.com
www.ofcconference.org

PhotonDelta gains €1.1bn funding, including €470m from Netherlands' National Growth Fund

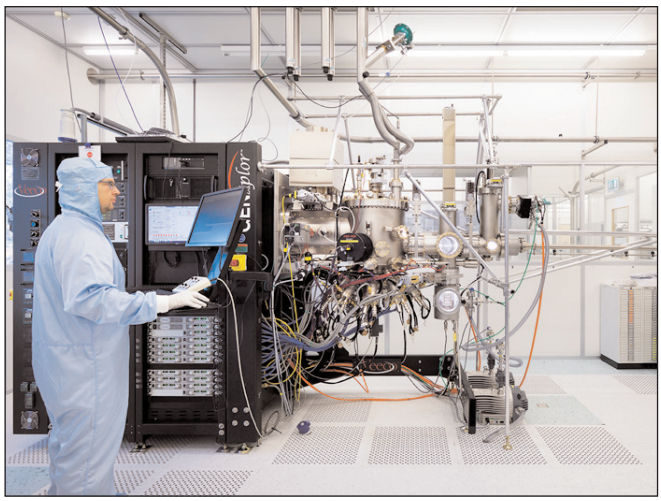
Six-year program to build 200 start-ups, scale up production, create new applications for photonic chips, and develop infrastructure and talent

Integrated photonics industry accelerator PhotonDelta, a cross-border ecosystem of photonic chip technology organizations, has secured €1.1bn in public and private investment (subject to certain conditions, including: agreeing a strategic partnership with a foundry; research activity connected with applications of technology; and ongoing evaluation of PhotonDelta's ecosystem).

As part of the Dutch Government's national plan to cement and expand the country's position in integrated photonics, the investment includes €470m obtained through the National Growth Fund (Nationaal Groeifonds), while the rest is co-invested by various partners and stakeholders.

The program will run for six years and enable PhotonDelta and its partners to further invest in photonic startups and scaleups, expand production and research facilities, attract and train talent, drive adoption, and develop a design library. By 2030, PhotonDelta aims to have created an ecosystem with hundreds of companies, serving customers worldwide and a wafer production capacity of 100,000+ per year.

Photonic integrated circuits (PICs) can overcome the expected limit to Moore's Law and will also help to tackle energy sustainability issues. PICs are currently used in the data and telecom industry to reduce the energy consumption per bit and increase speeds. With data and internet use expected to comprise about 10% of global electricity consumption by 2027, PICs provide a way to limit the impact on the climate. Photonic circuits will also soon play an important role for innovative sensors that can be mass produced, leading to earlier diagnostics of diseases, safe autonomous vehicles and infrastructure, and more efficient food production.

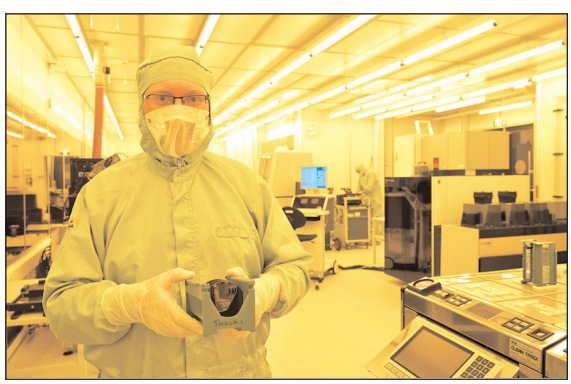


The Nanolab at Eindhoven University of Technology (photo: Bart van Overbeeke).

"The ongoing chip shortage highlights the pressing need for Europe to create its own production capabilities for strategic technologies," says PhotonDelta's CEO Ewit Roos. "We will now be able to support hundreds of startups, researchers, producers and innovators to boost this industry that will be as impactful as the introduction of microelectronics a few decades ago," he adds.

"The Netherlands is considered a pioneer in the development of PIC technology, and thanks to the continuous support from the Dutch government, we have been able to build a full supply chain around it that is globally recognized as a hotspot for photonic integration," Roos continues. "Photonic chips are one of the most important technological breakthroughs of the last decade. Not only do they allow for the creation of devices that are faster, cheaper, more powerful and greener — they also enable radical new innovations like affordable point-of-care diagnostics or quantum computing to become a reality."

The PhotonDelta proposal was submitted by the Netherland's Ministry of Economic Affairs & Climate Policy in collaboration with Eindhoven University of Technology (TU/e), University of Twente (UT), Delft University of Technology (TUD), Holst Centre, TNO (the Netherlands Organization for Applied Scientific Research in Delft), IMEC, PITC (Photonic Integration Technology Center), CITC (Chip Integration Technology Center), OnePlanet, Smart Photonics, Lionix International, Effect Photonics, MantiSpectra, PhotonFirst, Phix, and Bright Photonics.



Luc Augustin with a wafer containing photonic chips (photo: Bart van Overbeeke).

The PhotonDelta ecosystem currently consists of 26 companies, 11 technology partners and 12 R&D partners. The organization has so far jointly invested €171m in promising photonics companies including Smart Photonics, PhotonsFirst, Surfix, MicroAlign, Solmates and Effect Photonics.

www.photondelta.com/

Ayar Labs raises $130m in Series C funding

Investment to accelerate commercialization of first in-package optical I/O products

Ayar Labs of Santa Clara, CA, USA has secured $130m in additional financing led by Boardman Bay Capital Management to drive the commercialization of its integrated optical I/O solution, which is targeted at artificial intelligence (AI), cloud, high-performance computing (HPC), 5G, and light detection & ranging (LIDAR) applications.

Hewlett Packard Enterprise (HPE) and NVIDIA entered this investment round, joining existing strategic investors Applied Ventures LLC, GlobalFoundries, Intel Capital, and Lockheed Martin Ventures. Other new strategic and financial investors include Agave SPV, Atreides Capital, Berkeley Frontier Fund, IAG Capital Partners, Infinitum Capital, Nautilus Venture Partners, and Tyche Partners. They join existing investors such as BlueSky Capital, Founders Fund, Playground Global, and TechU Venture Partners.

"As a successful technology-focused crossover fund operating for over a decade, Ayar Labs represents our largest private investment to date," says Will Graves, chief investment officer at Boardman Bay Capital Management. "We believe that silicon photonics-based optical interconnects in the data-center and telecommunications markets represent a massive new opportunity and that Ayar Labs is the leader in this emerging space with proven technology, a fantastic team, and the right ecosystem partners and strategy," he comments.

"Optical connectivity will be important to scale accelerated computing clusters to meet the fast-growing demands of AI and HPC workloads," notes Bill Dally, chief scientist & senior VP of research at NVIDIA. "Ayar Labs has unique optical I/O technology that meets the needs of scaling next-generation silicon photonics-based architectures for AI."

Ayar Labs says that its optical I/O solution eliminates the bottlenecks associated with system bandwidth, power consumption, latency and reach, dramatically improving existing system architectures and enabling new, previously unrealizable solutions for AI, HPC, cloud, telecommunications, aerospace and remote sensing applications. With the new investment, Ayar Labs is ramping production and securing supply chain partners, as signaled by previously announced multi-year strategic collaborations with optical and photonic product makers Lumentum and MACOM as well as GlobalFoundries on its new GF Fotonix platform.

"Ayar Labs' highly differentiated technology is crucial to supporting the high-performance computing architectures of the future," believes Paul Glaser, VP & head of Hewlett Packard Pathfinder, HPE's venture arm. "Ayar Labs represents a strategic investment opportunity for HPE to help our customers more efficiently derive greater insights and value from their data," he adds.

"The overall financing is much larger than we originally targeted, underscoring the market opportunity for optical I/O and Ayar Labs' leadership position in silicon photonics-based interconnect solutions," says Ayar Labs' CEO Charles Wuischpard. "This financing allows us to fully qualify our solution against industry standards for quality and reliability and scale production starting this year."

Ayar Labs also says it has made its first volume commercial shipments under contract and expects to ship thousands of units of its in-package optical interconnect by end 2022.

www.ayarlabs.com

Synopsys and Juniper forming firm to offer 'laser-on-a-chip' open silicon photonics platform

Telecom, datacom, LiDAR, healthcare, HPC, AI and optical computing applications targeted

Synopsys Inc of Mountain View, CA, USA — which provides electronic design automation (EDA) software, semiconductor IP and services for chip and electronic system design — and optical network provider Juniper Networks Inc of Sunnyvale, CA, USA have closed a transaction to form a new, separate company that will provide an open silicon photonics platform to address the growing photonic requirements in applications like telecom, datacom, light detection & ranging (LiDAR), healthcare, high-performance computing (HPC), artificial intelligence (AI), and optical computing.

The new firm's open silicon photonics platform will include integrated lasers, optical amplifiers, and a full suite of photonic components to form a complete solution that will be accessible through a process design kit (PDK). It is expected that the platform will enable a new level of integration at an unmatched price point, with the lowest power consumption for high-performance photonic integrated circuits (PICs).

The new company will be jointly owned by Synopsys and Juniper, with Synopsys as the majority owner. Its results will be consolidated into Synopsys financials. While Synopsys expects the investment to be slightly dilutive to fiscal 2022 earnings, the investment is not material and will not affect its fiscal second-quarter and full-year 2022 guidance ranges provided on 16 February. There is no change to Juniper's full year financial outlook.

The new firm is being formed, in part, from the carve-out of integrated silicon photonics assets from Juniper, which includes more than 200 patents on photonic device design and process integration. While part of Juniper, the new company has closely collaborated with Tower Semiconductor to develop and qualify Tower Semiconductor's PH18DA process technology to enable what is reckoned to be the industry's first 'laser-on-a-chip' open silicon photonics platform. To demonstrate capabilities of this platform and accelerate customer adoption of the technology, the new firm has created 400G and 800G photonics reference designs with integrated lasers, and expects first samples to be available this summer.

"Silicon photonics is a rapidly growing market that is transforming many industries and creating exciting opportunities for new applications in the future," says Sassine Ghazi, president & chief operating officer at Synopsys. "The new company's open silicon photonics platform, combined with Synopsys' existing investment in a unified electronic photonic design automation solution consisting of OptoCompiler, OptSim, PrimeSim, Photonic Device Compiler and IC Validator products, will help reshape the optical computing industry, enabling companies to cost-effectively shift to integrated lasers and significantly accelerate development of photonic IC designs," he adds.

"This revolutionary technology will change the economics of how people are going to build photonic systems," says Juniper's CEO Rami Rahim. "We have been strong supporters of integrated silicon photonics and we believe the new company will drive development of these systems by using an advanced open platform that will dramatically reduce costs and increase the performance and reliability of designs across multiple use cases," he adds. "We are excited to continue to collaborate with the new company to enable a broad ecosystem to efficiently develop next-generation optical transceiver and co-packaged designs."

The new firm's open silicon photonics platform will include integrated lasers, optical amplifiers

A key challenge for silicon photonics has been the cost of adding discrete lasers, which includes the manufacturing as well as the assembly and alignment of those lasers onto the photonic chip. This becomes more important as the number of laser channels and the overall bandwidth increases. By processing the indium phosphide (InP) materials directly onto the silicon photonics wafer, the PH18DA platform reduces the cost and time of adding lasers, enabling volume scalability and improved power efficiency. In addition, monolithically integrated lasers on silicon wafers improves overall reliability and simplifies packaging. This 'laser-on-a-chip' open silicon photonics platform will bring integrated photonics to a host of new applications and markets that were previously not thought possible. The first multi-project wafer (MPW) is scheduled to be taped out in second-quarter 2022.

"We have had a long history of successful collaboration with Juniper Networks on integrated photonics," notes Tower Semiconductor's CEO Russell Ellwanger. "The new company formed by Synopsys and Juniper will strengthen and accelerate the adoption of the silicon photonics platform," he adds. "Providing an open silicon photonics platform consisting of integrated lasers that has been qualified on Tower's process will enable customers to create innovative products with the potential to transform the industry."

www.synopsys.com/photonic-solutions.html
www.juniper.net
www.towersemi.com

CompoundTek and Voyant to establish high-volume silicon photonic wafer test

Wafer-level testing for automotive LiDAR and applications such as robotics and drones

Singapore-based silicon photonic (SiPh) foundry services provider CompoundTek Pte Ltd has formed a strategic collaboration with light detection & ranging (LiDAR) solution provider Voyant Photonics of Long Island City, NY, USA to establish cost-effective high-volume SiPh wafer test for LiDAR designed specifically for automotive as well as other fast-growing applications such as robotics and drones.

Addressing the growing need for consistency and reliability for LiDAR products, the collaboration aims to use SiPh wafer test as a cost-effective method to identify known good die (KGD) through stringent testing at elevated temperature to meet global quality requirements for automotive and industrial applications. Wafer-level testing also allows LiDAR product companies like Voyant to have faster yield feedback to capture potential excursion in the fab earlier and to minimize the cost of yield dropouts in the later stages of the packaging process.

LiDAR remote sensing uses a pulsed laser to measure distances and to generate a precise, three-dimensional map of geographical locations. This is commonly used today in autonomous vehicles (AVs), drones and robots to enable obstacle detection, avoidance and safe navigation. SiPh technology is currently used for LiDAR products, and is leveraged on well-established silicon integrated circuit manufacturing processes which are cost effective and relatively easy to manufacture.

"CompoundTek is thrilled to be working with Voyant to provide a cost-effective test strategy that is capable of meeting stringent international standards," says IGSS Ventures' founder & group CEO Raj Kumar, who is also CompoundTek's CEO. "The key to market-wide adoption of wafer-level SiPh test lies in the cost and efficiencies of the test. This is particularly true for LiDAR, where comprehensive testing is done to meet the highest quality requirements for its end application, specifically in the automotive industry."

The integration of optical with electrical components on a single chip is creating multiple new challenges in wafer-level testing of SiPh devices as large volumes of optical, electrical and opto-electrical device-performance data are required through various stages of the product development life-cycles, from prototyping to qualification and subsequently into production. This is especially true for LiDAR, where it is used in automotive applications that demand a higher level of stringent quality and reliability requirements than usual consumer products. Stringent wafer testing for defects is necessary as the consequences of test escapes can be very costly, not to mention hazardous and detrimental to life as well as property.

Most companies have home-grown SiPh bench solutions, which are perhaps sufficient for small-scale engineering characterization during the initial design verification phase but inefficient for the high-throughput and low-cost test required for testing from risk production to the mass-production phase.

"The explosive growth of incorporating LiDAR in many applications requires us to test our SiPh chips in both timely and cost-efficient ways," notes Voyant's principal engineer Lawrence Tzuang. "A test platform that offers repeatable and reliable SiPh wafer-level electro-optical testing is critical to achieve this goal," he adds. "Working with a partner such as CompoundTek, which has both the test expertise and the capacity, allows us to focus on chip architecture and design, leading to both improved quality control for the manufactured chips and identifying failures in the earlier assembly steps."

An agnostics SiPh wafer test service provider with a cost-efficient wafer test solution is needed to address market gaps, including for the largest SiPh product companies who had to make do with modified testers and limited in-house capabilities. CompoundTek and Voyant say that their combined capabilities help the industry to drive down associated product costs and time from the product development cycle to mass manufacturing, and helps to accelerate the time to market.

www.voyantphotonics.com

CompoundTek demos hybrid Si O+C+L-band wavelength-tunable laser module

Silicon photonic foundry works with stealth-mode product company

At the recent LUX-Enterprise Singapore Copackaged Photonics/ASICs & Heterogeneous Integration Workshop, Singapore-based silicon photonic (SiPh) foundry services provider CompoundTek Pte Ltd shared results on a hybrid silicon O+C+L-band wavelength-tunable laser module that a stealth-mode product company ran with CompoundTek.

Through the development of the hybrid silicon laser technology, CompoundTek's team — led by chief operating officer KS Ang and principal engineer Dr Brian Sia together with key personnel from the stealth-mode product company — is claimed to be one of the first in the world to realise laser engines that operate simultaneously in the O, C and L wavebands. The laser engines have a wavelength tuning range of 175nm across the three wavebands, with an output power and side-mode suppression ratio (SMSR) as high as 40mW and 50dB, respectively.

As a corollary to advanced silicon manufacturing, silicon photonics has emerged as one of the fastest-growing technologies, says CompoundTek. However, due to the material properties of silicon, the realisation of laser sources has represented one of the final frontiers in the area. 'Lighting up Silicon' is thus a strategically imperative initiative that needs to be urgently addressed, the firm adds.

The primary advantage of a wavelength-tunable laser lies in its ability to reduce the complexity of optical systems; a single wavelength-tunable laser can be used to replace an array of single-wavelength lasers, simplifying the system architecture as well as lowering inventory cost.

While distributed feedback (DFB) laser arrays and micro-electro-mechanical systems (MEMS) vertical-cavity surface-emitting lasers (VCSEL) have been shown to demonstrate wavelength-tuning functionality, there are limitations in terms of DFB array coupler loss and mechanical instability, respectively. Littman/Littrow-configured external-cavity lasers (ECLs) have also exhibited a wide operating wavelength range; however the application space of this class of lasers is limited by their bulk, as well as greater vulnerability to environmental vibrations.

"The challenge is for the development of a solid state-based laser diode with compact footprint, and good performance that can be manufactured in a scalable, high-yield and low-cost process," says KS Ang. "While there are many ways to build a tunable laser, what sets CompoundTek's technology apart is our ability to integrate with silicon photonics devices which offer low propagation loss and high integration densities," he adds.

https://compoundtek.com

Emcore awarded contract extension for Medallion 8100 L-EML CATV transmitters

Shipments for European MSOs multi-year project to exceed $2m

Emcore Corp of Alhambra, CA, USA — which provides mixed-signal products for the aerospace & defense, communications and sensing markets — has been awarded a contract extension for Medallion 8100 Series linear externally modulated laser (L-EML) CATV transmitters by a major broadband multi-service operator (MSO) in Europe. The contract extension brings the value of L-EML transmitters shipped for this multi-year project to over $2m. For this phase of the project, Emcore expects that it will deliver transmitters beginning in second-quarter 2022.

Emcore's L-EML transmitter technology was launched at the ANGACOM 2016 Exhibition & Congress for Broadband, Cable and Satellite in Cologne, Germany and entered volume production in 2017.
The Medallion 8100 Series L-EML rack-mount transmitters being shipped for this project feature the proprietary optical device L-EML technology, consisting of a high-power, low-noise, narrow-linewidth laser combined with a highly linearized modulator in a monolithic assembly that enables long-distance optical link performance far exceeding that of distributed feedback (DFB) laser-based systems.

"This contract extension is a testament to the continuing success of our L-EML transmitters and we are extremely pleased to support this MSO's network expansion project in Europe," says senior product line director Grant Olecko. "We look forward to furthering our ongoing business relationship with future expansion projects with this customer."

Emcore is showcasing its linear fiber-optic transmission solutions for high-speed broadband at ANGACOM 2022 (10–12 May) with its partner EQ Photonics GmbH at the Koelnmesse in Cologne, Germany (Hall 7, booth #B20).

www.emcore.com

Silicon Ranch and First Solar expand partnership with 4GW supply agreement spanning 2023–2025

First Solar to provide recycling services for decommissioned modules

First Solar Inc of Tempe, AZ, USA has signed a master supply agreement (MSA) to supply 4GW$_{DC}$ of its cadmium telluride (CdTe) thin-film photovoltaic (PV) solar modules to Silicon Ranch of Nashville, TN, one of the USA's largest independent power producers.

Founded in 2011, Silicon Ranch is a fully integrated provider of customized renewable energy, carbon and battery storage solutions for partners across North America. The firm is one of the USA's largest independent power producers, with a portfolio that includes more than 4GW of solar and battery storage systems that are contracted, under construction or operating across the USA and Canada. Silicon Ranch owns and operates each project in its portfolio for the long term, and has commissioned every project that it has contracted. The firm now owns, operates and maintains more than 150 solar generating facilities in 15 states. Earlier this year, Silicon Ranch completed a $775m equity raise led by Manulife Investment Management.

The new deal, one of First Solar's largest, will see Silicon Ranch's projects in the USA receive modules from 2023 to 2025. Silicon Ranch will benefit from the evolution of First Solar's module technology platform over the span of the agreement.

The agreement represents the latest milestone in the relationship between two solar businesses. The growing strategic partnership began in 2015 when Silicon Ranch contracted First Solar to supply the modules for its Aerojet Rocketdyne Solar Farm in Arkansas, the state's first utility-scale solar project. The partnership has grown across the USA since then, to more than 30 projects totaling over 1GW.

"Silicon Ranch's business model of long-term asset ownership demands that we emphasize best-in-class strategic partners and requires us to consider the future in every action we take, from the modules we buy all the way through to how we manage the land we occupy," says Silicon Ranch's co-founder & CEO Reagan Farr. "We are already proving that we can sequester carbon on our sites through our Regenerative Energy model of land management, and this partnership with First Solar enables us to improve the carbon footprint of our module supply, while also supporting additional investment in US manufacturing capabilities," he adds. "We have grown our business at Silicon Ranch through our faith in the power of collaborative partnerships."

Under the agreement, end-of-life CdTe modules from Silicon Ranch projects can be processed by First Solar's high-value recycling program, which recovers about 90% of CdTe material (which can be used to manufacture new modules) as well as other materials including aluminium, glass and laminates. Additionally, the recycled glass can be converted into useful glass products for beneficial use, while laminates can be processed into rubber products including shoe soles and bicycle handles. First Solar currently operates commercial recycling facilities in the USA, Germany, Malaysia and Vietnam.

"Since the beginning of our relationship, it has been clear that Silicon Ranch recognizes the value of taking a long-term view on procuring solar technology," comments First Solar's chief commercial officer Georges Antoun. "Long-term module supply agreements with a trusted partner provide a vital hedge against the pricing and supply uncertainties that have impacted the solar industry over the past few years. And with First Solar's agile contracting strategy, Silicon Ranch will have the added benefit of access to our best-in-class PV technologies as they continue to evolve."

First Solar is investing $680m in expanding America's domestic PV solar manufacturing capacity by 3.3GW annually, by building its third US manufacturing facility, in Lake Township, Ohio. The new facility is expected to be commissioned in first-half 2023 and, when fully operational, will scale the company's Northwest Ohio footprint to a total annual capacity of 6GW (making it the largest fully vertically integrated solar manufacturing complex outside China, it is believed). First Solar has invested over $2bn in its US manufacturing footprint and, when its third factory is fully operational, will directly employ over 2500 people in Ohio, while supporting an estimated 7000 indirect jobs through its American supply chain.

In addition to its Ohio manufacturing facilities, First Solar also operates factories in Vietnam and Malaysia, and is building a new 3.3GW factory in India that is expected to be commissioned in second-half 2023. With First Solar's expansion in the USA and India and optimization of its existing fleet, the firm expects that its nameplate manufacturing capacity will double to 16GW in 2024. First Solar is the only US-headquartered company among the world's ten largest solar manufacturers.

www.siliconranch.com
www.firstsolar.com

Nevada Gold Mines orders 260MW of First Solar modules

Cadmium telluride PV modules to power 17% of energy needs of world's largest gold-producing complex

First Solar Inc of Tempe, AZ, USA says that its cadmium telluride (CdTe) thin-film photovoltaic (PV) solar module technology will power 17% of the annual energy needs of Nevada Gold Mines (NGM). NGM is operated by Barrick Gold Corp and is a joint venture between Barrick (61.5%) and Newmont Corp (38.5%) that combined their assets across Nevada in 2019 to create the world's largest gold-producing complex.

NGM, which produces about 3.5 million ounces of gold a year, is investing in building a solar power plant as part of a broader effort to decarbonize its operations and minimize its environmental footprint. As part of the deal, which was booked prior to the release of First Solar's fourth-quarter 2021 earnings in February, 260MW_{DC} of solar modules manufactured by First Solar in Ohio will be deployed to power the new 200MW_{AC} facility in second-quarter 2023.

Barrick has committed to a 30% greenhouse gas reduction by 2030, with the goal of net-zero operations by 2050. NGM will support Barrick's targets and has set an intermediate goal of reducing its greenhouse gas emissions by 20% (compared with its 2018 baseline) by 2025. This is expected to be achieved by the solar power plant and conversion of NGM's coal-fired power plant to cleaner burning natural gas.

They partnered with us because we can deliver a high-performance module that comes without the social, environmental and political risks that are, unfortunately, associated with too many solar manufacturers today

"We made the choice to contract with a supplier who shares our values, including a commitment to fair labor practices and investment in American manufacturing and American jobs," says NGM's executive managing director Greg Walker. "By partnering with First Solar we also found an innovator that can deliver high-performance solar panels with the lowest carbon footprint and the best environmental profile available today," he adds. "While minimizing the environmental impacts of our operations, we bring sustainable long-term social and economic benefits to Nevada."

"NGM is part of a growing wave of customers that are unwilling to compromise on quality or their principles, and choose to partner with First Solar," says First Solar's chief commercial officer Georges Antoun. "They partnered with us because we can deliver a high-performance module that comes without the social, environmental and political risks that are, unfortunately, associated with too many solar manufacturers today."

www.barrick.com/English/operations/nevada-gold-mines

Origis Energy orders 750MW of First Solar modules

Modules due for 2024 delivery, building on long-term alliance

Origis Energy of Miami, FL, one of America's largest solar and energy storage developers, has placed an order for 750MW_{DC} of First Solar's cadmium telluride (CdTe) thin-film photovoltaic (PV) solar modules. The deal, which was booked prior to the release of First Solar's fourth-quarter 2021 earnings in February, utilizes First Solar's agile contracting approach and Origis will benefit from any advances in technology through 2024, when the modules will be delivered to its projects across the USA.

First Solar and Origis share a long-standing relationship spanning five years and over 1.5GW_{DC} of modules. "This 750MW solar agreement builds on a long-term alliance between the First Solar and Origis teams," says Samir Verstyn, Origis Energy's chief investment officer and operations officer. "Front and center is always our commitment to meet customer clean energy goals. This mission has been put to the test by the unprecedented headwinds impacting the solar industry. Such an environment makes it even more important to work with market partners who have consistently delivered," he adds. "We applaud First Solar's build out of its domestic PV solar manufacturing capacity. Today's announcement is an important step forward in fulfilling the renewable energy goals of our utility and corporate customers across America."

"At First Solar, we value long-term relationships with partners like Origis because they are based on trust and a respect for mutually-held values and principles," said Georges Antoun, chief commercial officer, First Solar. "At a time of unprecedented supply and pricing volatility across the solar industry, our ability to deliver and stand behind our commitments is a crucial differentiator that serves to strengthen relationships like these."

www.firstsolar.com

N-polar InGaN LEDs with record output power

UCSB has used an inverted structure with the p-GaN layers buried beneath the quantum wells to yield better-quality p-GaN at a higher growth temperature.

University of California Santa Barbara (UCSB) in the USA claims record high power of up to 0.21mW at 20mA current injection for nitrogen-polar indium gallium nitride (InGaN) LEDs grown by metal-organic chemical vapor deposition (MOCVD) [Vineeta R. Muthuraj et al, Appl. Phys. Lett., v120, p101104, 2022]. The devices produced blue to blue–green light with wavelengths between 470nm and 506nm.

Although Ga-polar devices generate higher light output power, there are a number of properties of N-polar material that could be handy in future development. For starters, N-polar GaN more easily incorporates indium, potentially allowing longer wavelengths to be reached. In addition, charge transport is better, offering opportunities to reduce efficiency droop at high current injection. Unfortunately, up to now N-polar devices have only managed up to 20μW at 20mA injection.

Another unusual feature of the UCSB devices was the use of an inverted structure with the p-type layers buried underneath the light-emitting quantum wells (QWs). This allows better quality p-GaN to be grown at a higher temperature, but creates problems for activating the magnesium (Mg) doping, which is passivated by hydrogen, impossible to avoid in MOCVD processes. Vias were drilled by etching into the material to allow hydrogen to escape during thermal annealing from the buried p-GaN layers.

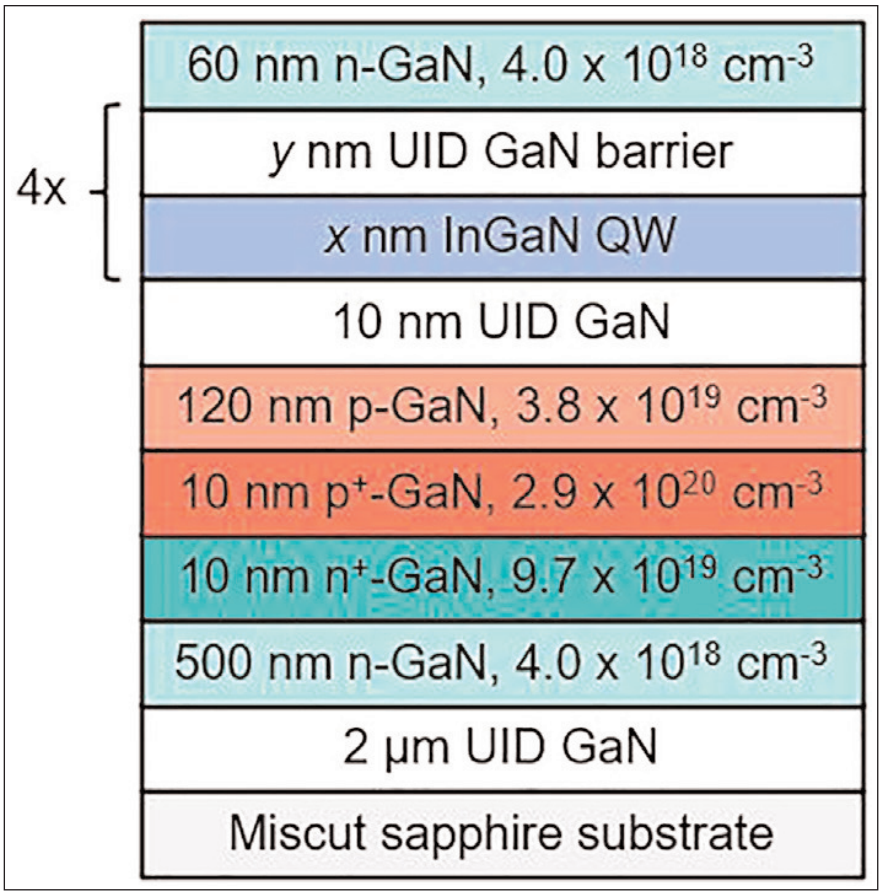


Figure 1. Epitaxial structure of inverted N-polar LED with doping levels obtained from secondary-ion mass spectrometry (SIMS).

The normal p-GaN-on-top structure is restricted in growth temperature by the imperative not to thermally degrade the underlying InGaN QWs. The resulting p-GaN material tends to have a high resistance to current flow. In the inverted structure, relatively low-resistance n-GaN can be achieved with a lower growth temperature.

Electrical power to inject holes into the QW active region was supplied through a thin tunnel junction with n-type material.

The N-polar material (Figure 1) was grown on 4° misoriented sapphire. The metal-organic precursors were trimethy- and triethyl-Ga and trimethyl-In. The silicon (Si) and magnesium (Mg) dopants were sourced by disilane (Si_2H_6) and bis-cyclopentadienyl Mg (Cp2Mg), respectively. The nitrogen came from ammonia (NH_3).

The light-emitting quantum wells (QWs) consisted of InGaN of thickness between 1.5nm and 4.5nm and GaN barriers between 7nm and 15nm.

The initial unintentionally (UID) and n-type doped GaN layers were grown at 1200°C. The temperature was reduced to 800°C for the heavily doped n^+-GaN tunnel-junction layer, and then raised to 1080°C for the p-type layers and the 10nm UID GaN spacer. The wells were grown at 800°C, and the barriers at 830°C. The final 60nm n-GaN was produced at 900°C.

The LED fabrication began with mesa and activation via reactive-ion etch using silicon tetrachloride ($SiCl_4$), followed by buffered hydrofluoric acid and ultraviolet

ozone treatments. The device area was 0.1mm^2.

The circular activation vias were 3μm diameter in a square array. The center-to-center distance was 6.5μm. The activation itself consisted of 700°C rapid thermal annealing for 30 minutes.

Aluminium/nickel/gold were used for the contacts to the n-GaN of the top and bottom of the device.

The electroluminescence spectra were single-peaked with a shoulder on the short-wavelength side being attributed to "a combination of InGaN alloy compositional fluctuations and thickness fluctuations in the quantum wells".

A blue LED with 1.5nm/11nm wells/barriers had a 470nm peak wavelength with 40nm full-width at half maximum (FWHM) at 20mA DC injection. The wavelength and FWHM were fairly stable in the range 5–100mA with most-likely self-heating counteracting blue-shift effects. The self-heating was the result of lower efficiency relative to Ga-polar devices. The light output power of the brightest device at 20mA was 0.21mW. The peak power was 0.97mW at 244mA.

The turn-on voltage was high at ~6V. "The excess voltage may be explained by incomplete activation of the Mg dopants in the buried p-GaN layers," the team explains. The researchers suggest micro-LED formats and improvement of the tunnel-junction structure could reduce the voltage. Micro-LEDs have increased area for the escape of hydrogen during activation.

The external quantum efficiency (EQE) peaked around 5A/cm^2 injection current density. The EQE dropped by 37% when the density reached 100A/cm^2. The researchers comment: "Previously published N-polar LED EQE data showed 33% droop with integrated EQE measurements going up to only 12A/cm^2."

The devices with varied well and barrier thicknesses enabled emission wavelengths of 506nm to be reached under 20mA (20A/cm^2) DC injection (Figure 2).

SIMS studies showed oxygen and carbon impurity levels comparable to or higher than previous work on N-polar devices with 6μW-level light output power. The team comments: "With impurities being a less likely factor in poor N-polar luminescence, the primary reason for the improvement in this work is most likely the growth of the p-GaN layers at high temperature, which was enabled by the inverted structure." ■

https://doi.org/10.1063/5.0083893

Author: Mike Cooke

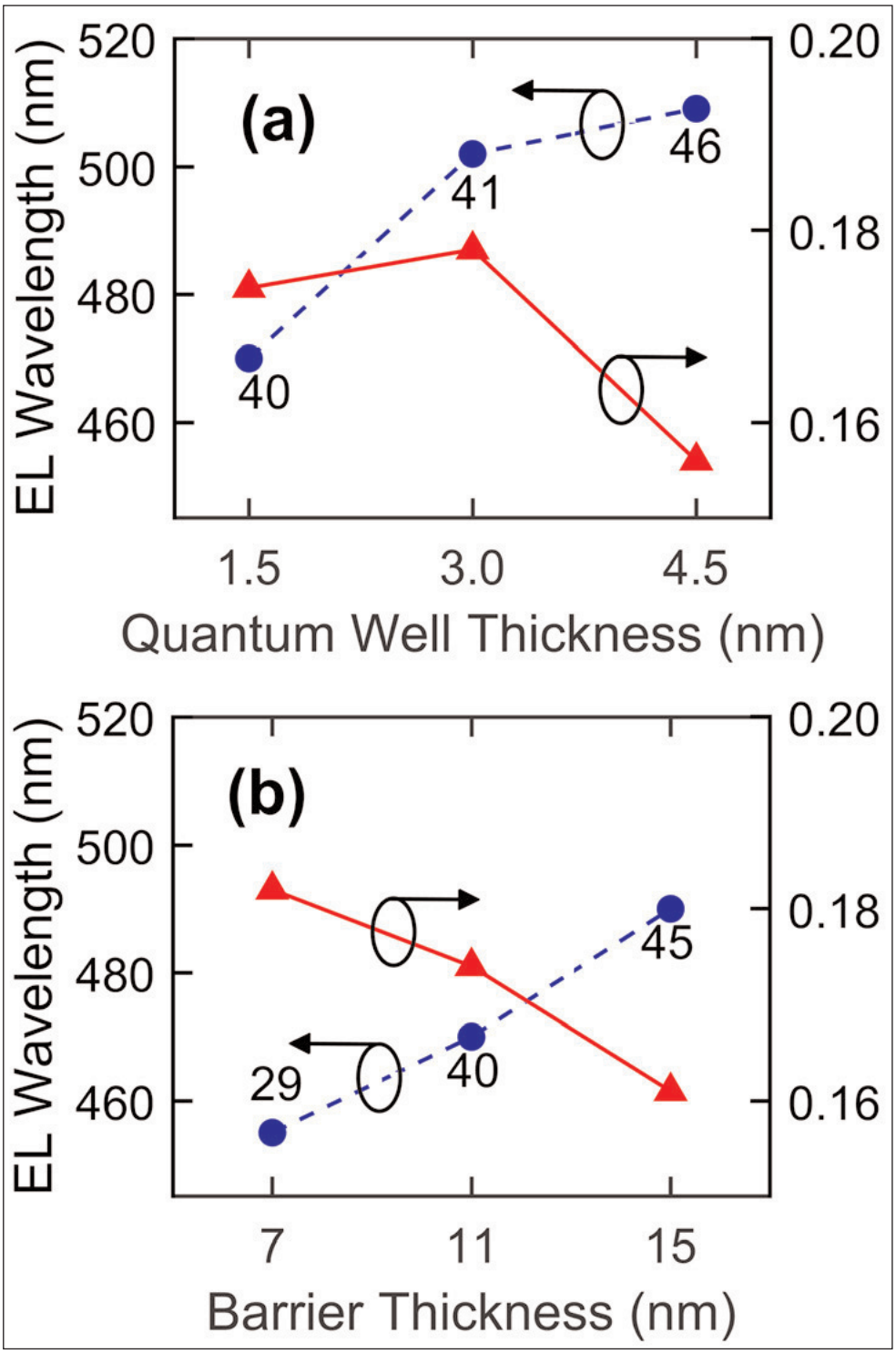


Figure 2. Electroluminescence wavelength and light output power versus (a) quantum well thickness with 11nm wide barriers and (b) barrier thickness with 1.5nm wide quantum wells. Wavelength points labeled with FWHM in nanometers.

Optimizing InGaN templates

LED on template with effective 8.5% indium content shows 1.9x improved efficiency over conventional device.

North Carolina State University in the USA has been investigating the potential of indium gallium nitride (InGaN) for enhancing the performance of III–nitride light-emitting diodes (LEDs) [Mostafa Abdelhamid et al, Appl. Phys. Lett., v120, p081104, 2022].

The reduced strain in InGaN quantum wells (QWs) grown on InGaN templates should increase light output, particularly for the longer wavelengths desired in micro-LEDs and full-color displays — but there is a trade-off since such templates have higher defect densities relative to pure GaN. For commercial use, the former effect must significantly outweigh the latter.

The balance arises through the strain effects of lattice and thermal expansion mismatching between GaN and the target InGaN. Using an intermediate InGaN template should lighten these constraints.

The team used commercial substrates with 5μm n-GaN on sapphire with ~10^8/cm^3 dislocation density to grow InGaN QWs on InGaN templates (Figure 1). The researchers employed their own metal-organic chemical vapor deposition system with substrates rotating under alternating streams of III and V precursors.

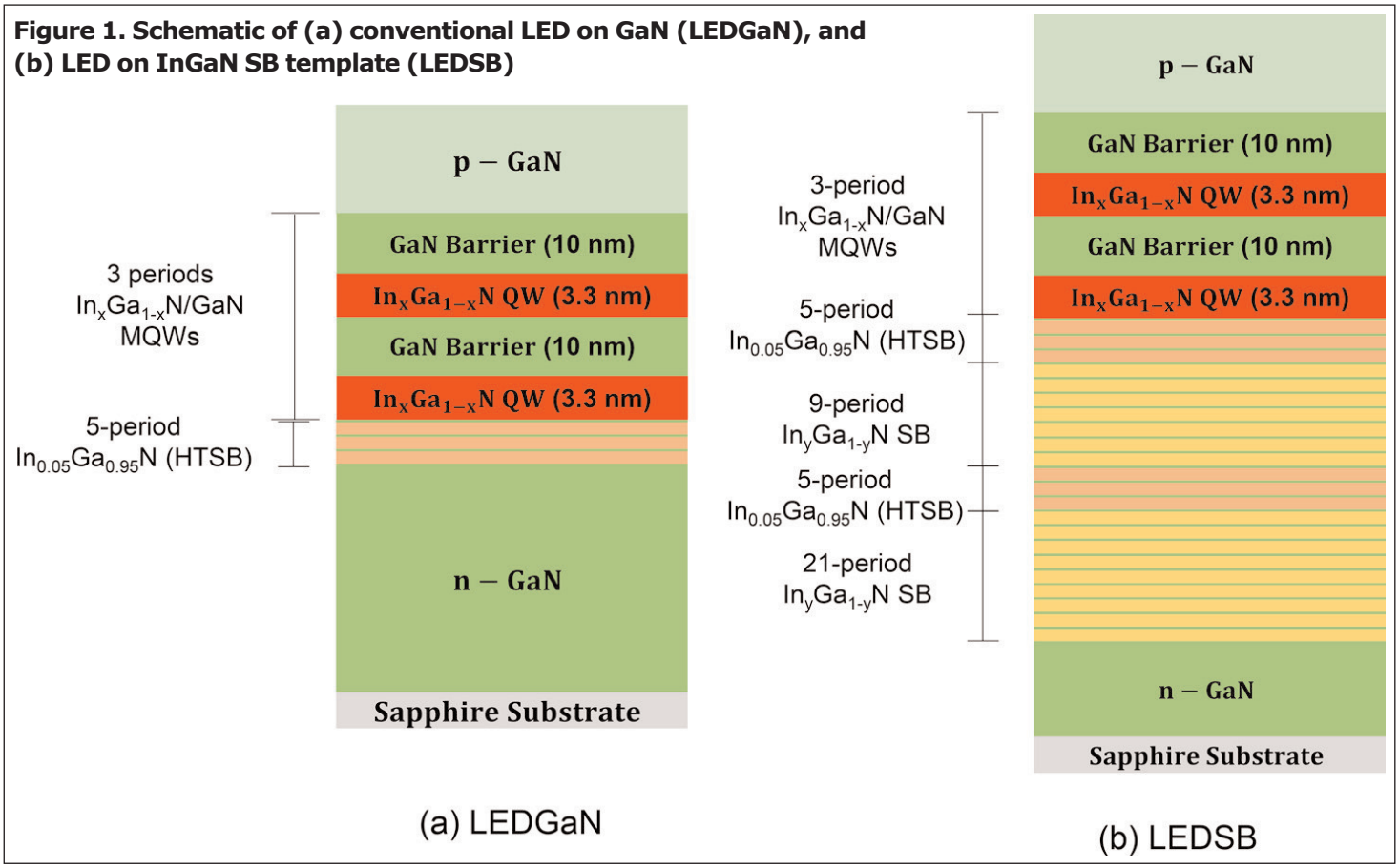
Main precursors were trimethyl-In/Ga for the group-III metals and ammonia (NH_3) for the group-V nitrogen. However, the QWs were grown with triethyl- rather than trimethyl-Ga.

The ~600nm InGaN template was produced using what the researchers call a semi-bulk (SB) approach where 30-periods of 20nm InGaN layers were separated by 2-4nm GaN caps. These thicknesses gave optimized surface morphology with reduced V-pit size and depth, according to research by the team and others.

The effective indium content varied according to growth temperature. The template indium contents were 8–12% (see Table). The researchers comment: "We define the effective indium content as the reduced indium content value that corresponds to full relaxation in the top layers of the SB templates. For example, a template with an indium content of 10% that is 85% relaxed is equivalent to a fully relaxed template with an effective indium content of 8.5%."

The QWs grown on the template at 710°C were capped with 1nm aluminium gallium nitride ($Al_{0.25}Ga_{0.75}N$), presumably to reduce decomposition of the InGaN layer during the 100°C higher temperature GaN growth. The use of triethyl-Ga with very low molar flow

Figure 1. Schematic of (a) conventional LED on GaN (LEDGaN), and (b) LED on InGaN SB template (LEDSB)



LED	SB1	SB2	SB3	SB4
Temperature	745°C	740°C	735°C	730°C
In content	8.5%	9%	10.5%	11%

(0.78μmol/min compared with 3μmol/min for conventional wells) reduced indium incorporation to give similar wavelength performance (~475nm) across the different templates studied. The p-GaN contact layer was grown at 975°C.

Both the conventional and template materials used high-temperature (HT) SB layers before the QWs. These consisted of $In_{0.05}Ga_{0.95}N$ layers grown at 770°C. These layers were used to "improve the electron injection into the active region and slightly reduce the strain in the wells". The HTSB also improves surface morphology for the QW growth. An HTSB section was also inserted in the template layer with a view to further reducing defects.

Material was fabricated into 400μm x 400μm LEDs. LEDSB1 and LEDSB2 devices showed enhanced light output power and external quantum efficiency (EQE) over the conventional LED, but the higher-indium-content templates showed degraded performance (Figure 2). In fact, degradation was monotonic so LEDSB1's performance was better than LEDSB2's, while both were better than the conventional device (LEDGaN). The peak EQE of LEDSB1 was about 1.9x higher than LEDGaN.

The researchers attribute the improvements over the conventional LED to reduced electrical fields in the active region. These electric fields arise from the charge polarization of the III–V chemical bonds leading to strain-dependent effects. When electric fields are present in the active regions they tend to inhibit electron-hole recombination into photons, what researchers often describe as the 'quantum-confined Stark effect' (QCSE).

The degradation with increased indium-content templates is attributed to increased surface roughness, and deeper, wider V-pits.

"There are optimum indium-content values in the template where the improvement due to the reduction in the strain is stronger than the deterioration added by the increased surface roughness and increased defect density," says the team.

The lower-indium-content template LEDs also showed reduced saturation current under reverse bias, again indicating reduced defect density. ■

https://doi.org/10.1063/5.0084273

Author: Mike Cooke

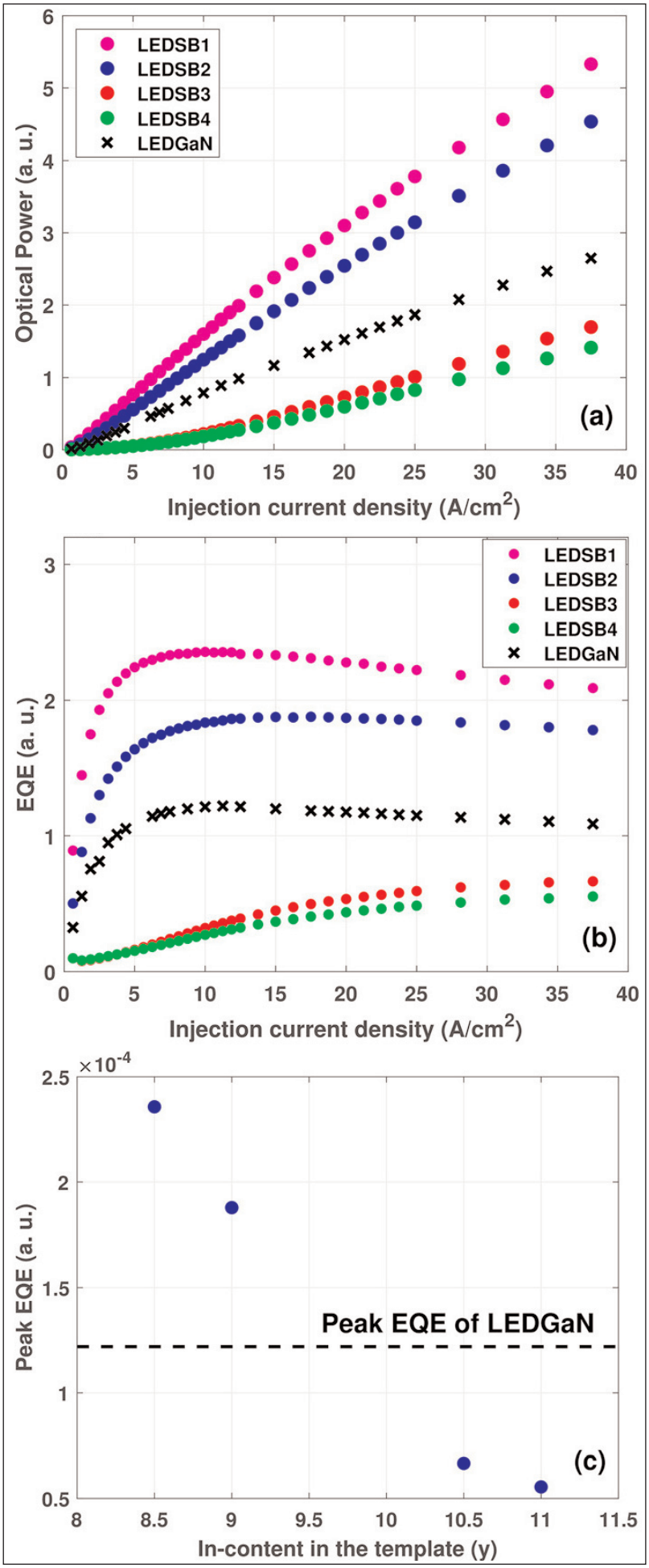


Figure 2. Comparison of (a) optical power measurements and (b) relative EQE for LEDGaN and LEDSB1-LEDSB4. (c) Peak EQE versus indium content in underlying template. Horizontal line shows peak of LEDGaN.

Achieving thicker AlGaN material

Researchers explore non-planar growth on a gallium nitride mesa to produce laser diode structures beyond the critical thickness for cracking.

Georgia Institute of Technology and Arizona State University in the USA have used non-planar growth (NPG) of aluminium gallium nitride (AlGaN) on patterned GaN on sapphire to create material with thicknesses beyond critical with a view to ultraviolet laser diodes [Frank Mehnke et al, J. Appl. Phys., v131, p073103, 2022].

Lattice mismatch and thermal expansion mismatch between AlGaN and GaN often lea to cracking of the material from the build up of stress.

The reported experimental critical thicknesses of $Al0_{.17}Ga_{0.83}N$ and $Al_{0.21}Ga_{0.79}N$ are less than ~620nm and ~200nm, respectively. The Georgia/Arizona work achieved laser diode structures with total AlGaN thickness ~1.5μm without cracking.

Contact	p-GaN	10nm
Cladding	p-AlGaN SL	500nm
Waveguide	p-$Al_{0.06}Ga_{0.94}N$	150nm
Electron block	p-$Al_{0.3}Ga_{0.7}N$	10nm
Cap	$Al_{0.3}Ga_{0.7}N$	20nm
MQW	2x($In_{0.02}Ga_{0.98}N$/$Al_{0.09}Ga_{0.91}N$)	3nm/9nm
Barrier-1	$Al_{0.09}Ga_{0.91}N$	30nm
Waveguide	n-$Al_{0.06}Ga_{0.94}N$	150nm
Cladding	n-AlGaN SL	600nm
Buffer	n-GaN	300nm

Figure 1. Structure of laser diode material.

The team comments: "We believe that this approach can also be extended to NPG growth on bulk GaN substrates as well as other tensile-strained semiconductor systems."

The templates for the work consisted of 2.7μm-thick GaN on sapphire, grown by metal-organic chemical vapor deposition (MOCVD). X-ray analysis showed the threading dislocation density in the GaN to be ~$2x10^9/cm^2$.

The GaN layer was patterned with 2mm-long stripe mesas of various widths between 10μm and 200μm, created using photolithography and plasma etch with silicon dioxide masking. The stripes were placed at various spacings from 10μm to 200μm. The stripes were oriented along the $[1\bar{1}00]_{GaN}$ symmetry direction. The aim was to ease the cleaving of the material for laser facets in the perpendicular $\{1\bar{1}00\}_{GaN}$ symmetry plane.

The mesa etch depth varied between 500nm and 3000nm. The deepest etch depth (3000nm) cut into the sapphire substrate. The mesa sidewalls were "near vertical". The root-mean-square (rms) roughness was estimated at ~0.6nm on a 5μmx5μm field.

The researchers studied the MOCVD growth of 5nm-period AlGaN superlattices of various pairings of

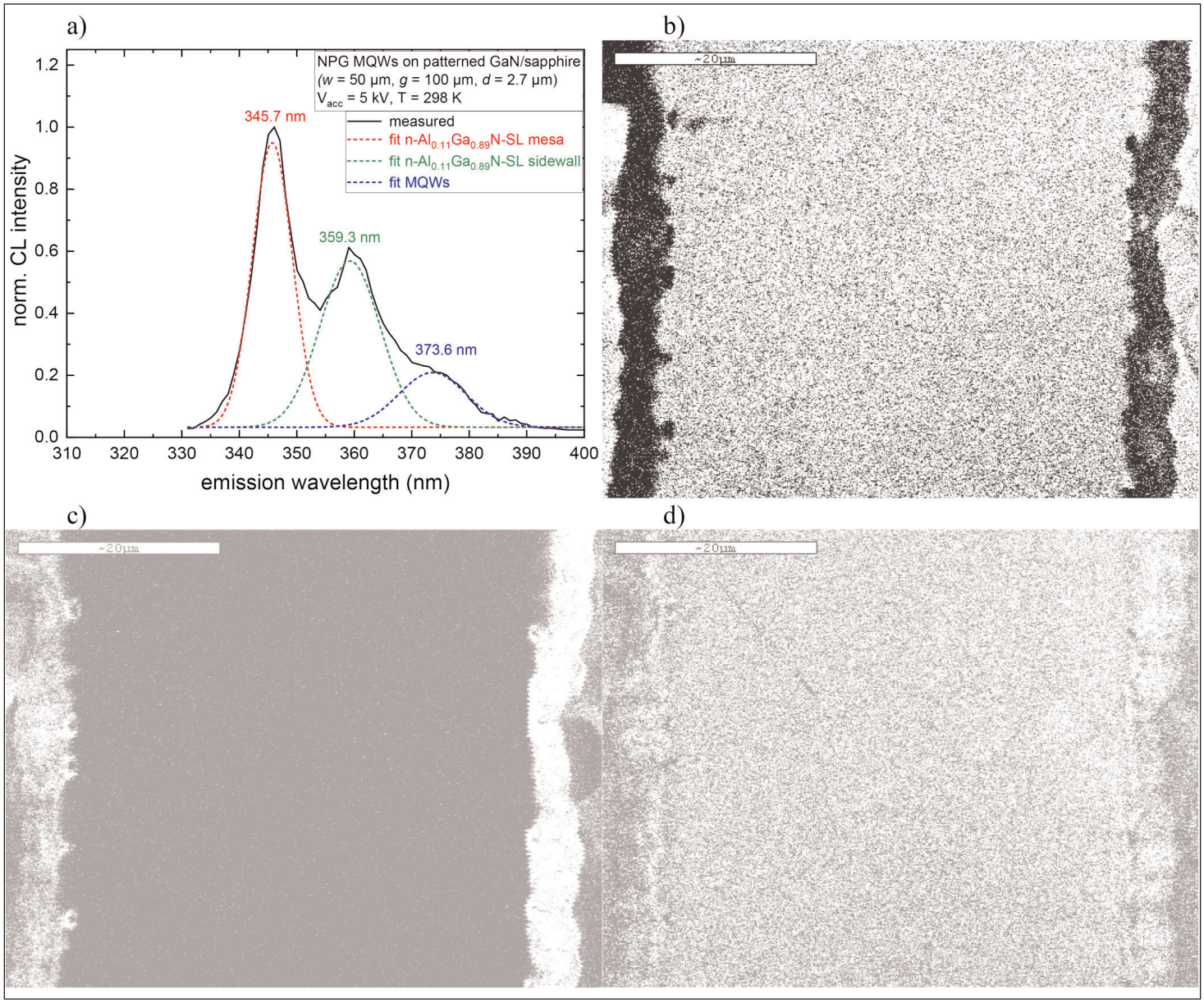


Figure 2. (a) CL spectra at room temperature of NPG MQW heterostructure and monochromatic CL maps at (b) 345.7, (c) 359.3 and (d) 373.6nm.

Al composition: 0.06/0.16, 0.11/0.21, and 0.16/0.26. The average compositions were 0.11, 0.16, and 0.21, respectively.

The researchers found that cracks formed in two stages: first, cracks between the stripes emerged in a [11$\bar{2}$0] direction perpendicular to the mesa stripes; later, the cracks formed networks along the <11$\bar{2}$0> symmetry directions.

The researchers comment: "The formation of the first cracks perpendicular to the mesa stripe orientation is most likely caused by an anisotropic strain distribution along the mesa as material can relax toward the mesa edges but is limited in relaxation along the mesa stripe."

The team found that cracking was primarily avoided by reducing the mesa stripe width.

The researchers used material grown on 2.7µm-deep mesas (i.e. 3000nm etch depth) with 100µm gap to create laser diode heterostructures (Figure 1). The superlattices (SLs) consisted of 5nm-period 0.06/0.16nm (0.11nm) Al content. The total AlGaN thickness was ~1470nm, "much larger than the critical layer thickness for these materials," the team comments.

The researchers comment: "This heterostructure design is based upon the modeling of the optical properties of the heterostructure with the goal of increasing the optical confinement factor while not increasing the electrical resistance too much."

Under electron-beam excitation (cathodoluminescence) on material 50µm mesa widths, the structure emitted light with spectral peaks at 345.7nm, 359.3nm and 373.6nm (Figure 2). The researchers believe that these peaks were associated with emissions from the mesa, sidewall and multiple quantum well (MQW) regions, respectively.

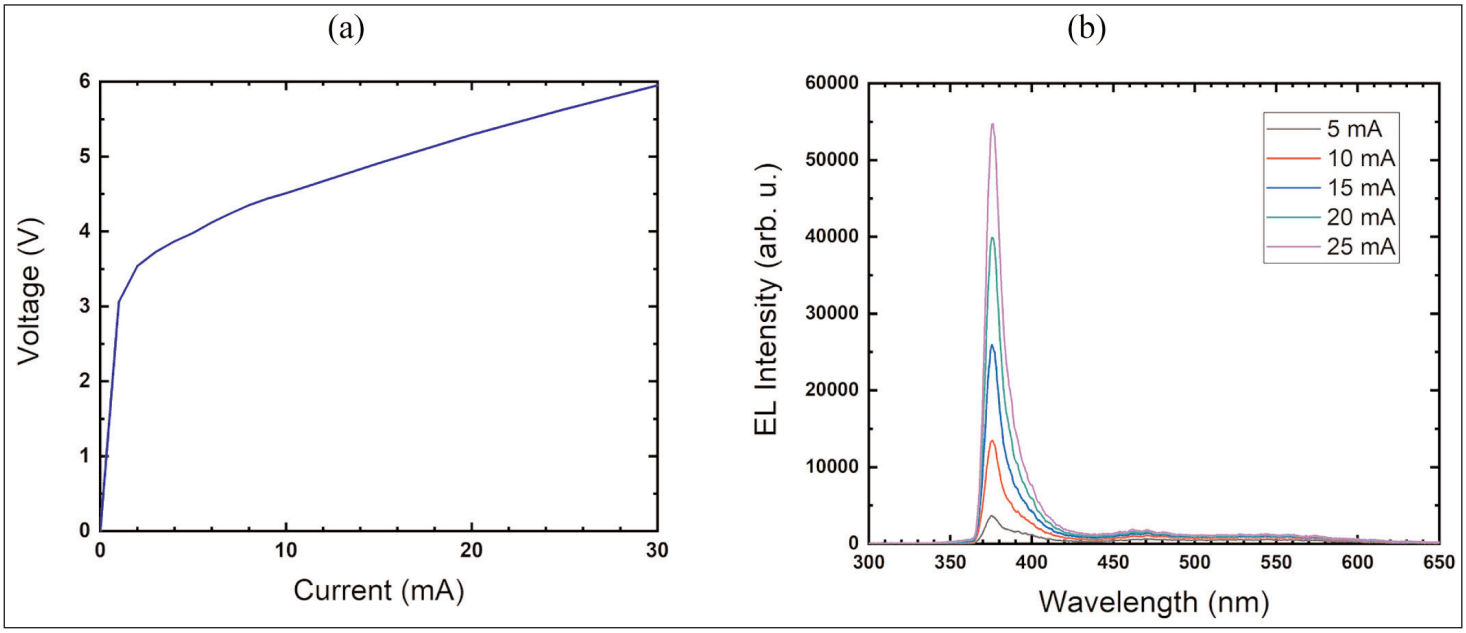


Figure 3. (a) Voltage-current plot and (b) 300K injection-current-dependent EL spectra of edge emission of a 30μm wide NPG/GaN/sapphire laser diode stripe for various DC drive currents.

Fabricated 30μmx1000μm laser diodes emitted 376.8nm electroluminescence (EL) with 13nm full-width at half-maximum (FWHM) at 25mA current injection (Figure 3). No threshold is mentioned, so one presumes that lasing was not achieved yet. ■

https://doi.org/10.1063/5.0073489

Author:
Mike Cooke

semiconductorTODAY

COMPOUNDS & ADVANCED SILICON

www.semiconductor-today.com

Join our LinkedIn group: Semiconductor Today

Follow us on Twitter: Semiconductor_T

Choose *Semiconductor Today* for . . .

MAGAZINE

Accurate and timely coverage of the compound semiconductor and advanced silicon industries

Targeted 82,000+ international circulation

Published 10 times a year and delivered by e-mail and RSS feeds

WEB SITE

Average of over 26,000 unique visitors to the site each month

Daily news updates and regular feature articles

Google-listed news source

E-BRIEF

Weekly round-up of key business and technical news

E-mail delivery to entire circulation

Banner and text marketing opportunities available

Extending interband cascade laser wavelength

Researchers claim 13μm record in pulsed mode and improved continuous-wave performance at shorter wavelengths.

University of Oklahoma and Sandia National Laboratories in the USA have reported a record long wavelength for III–V interband cascade lasers (ICLs) of more than 13μm [J. A. Massengale et al, Appl. Phys. Lett., v120, p091105, 2022].

The research team also reports improved performance of shorter ~11μm wavelength devices in continuous wave (cw) operation. These coherent mid-infrared wavelengths find employment in gas/chemical sensing, imaging, and industrial process control.

The ICL structures were grown on indium arsenide (InAs) substrates, using molecular beam epitaxy (MBE). ICLs are frequently grown on gallium antimonide (GaSb), spanning the 3–6μm range, operating even at room temperature (300K). At present, GaSb structures suffer from the needed optical cladding becoming too thick at longer wavelengths.

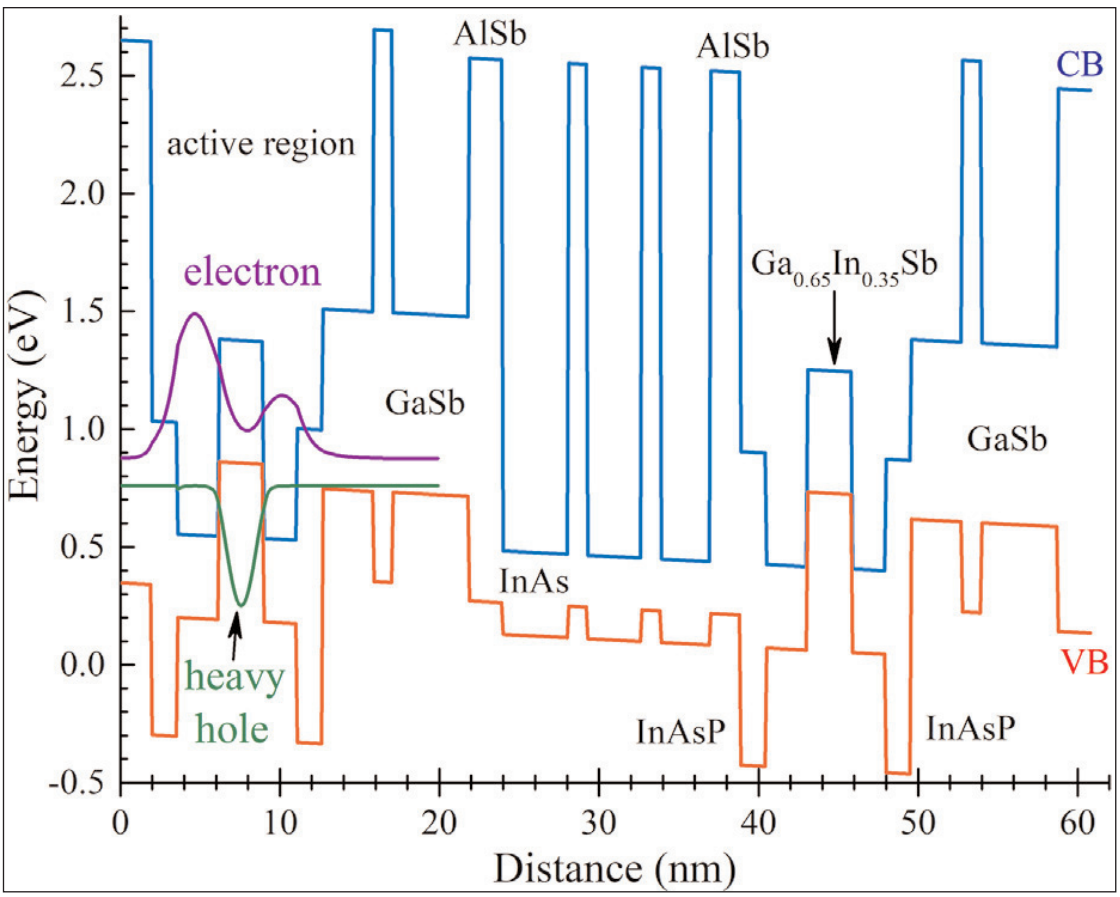


Figure 1. Band-edge diagram of one cascade stage and layer sequence for longer-wavelength ICL wafer.

The advanced waveguide structure for the Oklahoma/Sandia work consisted of 1.65μm intermediate superlattice cladding and 0.83μm InAs separate-confinement layers (SCLs).

Further optical confinement was provided by n^+-InAs plasmon cladding layers — 2μm on the bottom and 1.1μm on the top. The plasmon cladding used 54% reduced doping compared with the group's previous work with the aim of reducing optical losses from free-carrier absorption. 'Plasmons' refer to the quasi-particles of the quantum description of the plasma oscillations of electron charge density responsible for the typical visible light reflectivity of metals.

The light-generating 20-stage cascade structure (Figure 1) was grown with and without phosphide barrier layers. The indium arsenide phosphide (InAsP) layer insertion between an aluminium antimonide arsenide (AlSbAs) barrier and InAs electron well improved the overlap of the electron and hole wave-functions, enhancing recombination into photons in the W-shaped 'type-II' well structure. The hole well consisted of gallium indium antimonide (GaInSb).

The researchers comment that the InAsP barrier "can lower the electron energy level for longer-wavelength emission without increasing the InAs layer thickness." The lower electron level reduces the energy gap with the hole energy, which should lead to lower-energy, longer-wavelength photons.

The laser material was fabricated into broad-area cavities cleaved into 1.5mm-long bars epi-side up on

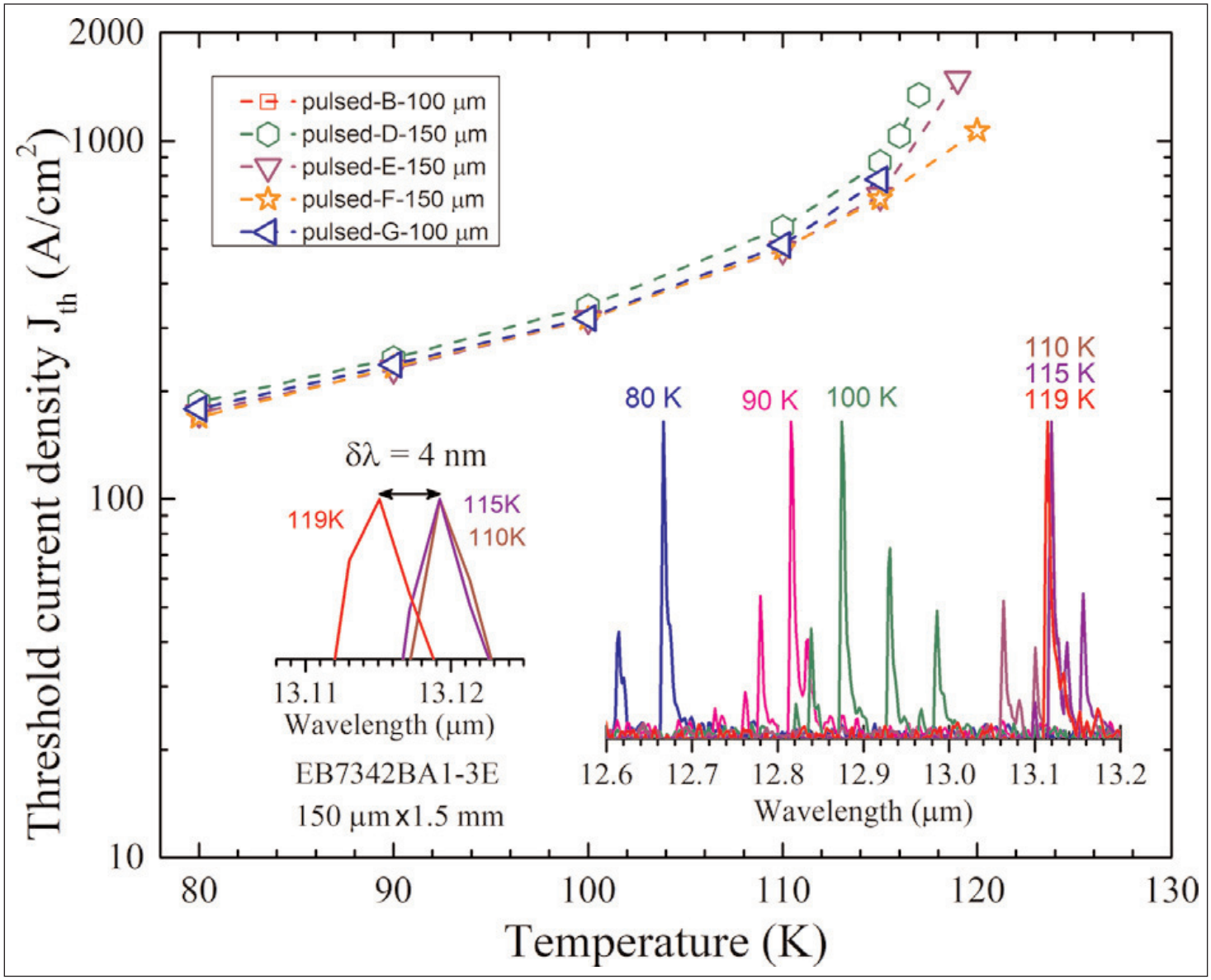


Figure 2. Threshold current density as function of temperature for several 100μm- and 150μm-width devices from wafer with InAsP barrier. Right inset: pulsed lasing spectra; left inset: zoomed-in view of blue-shift between 110–119K.

copper heatsinks. There was no facet coating.

The structure without InAsP barriers emitted laser light around 11μm in cw mode up to 100K, and in pulsed mode up to 130K. The InAsP lasers only operated in pulsed mode up to 120K, but the 13μm wavelength was the longest reported so far for III–V interband lasers.

The cw performance of the ICL without InAsP barrier layers had a 23A/cm^2 threshold at 80K, about four times smaller than the group's previous 20-stage ICL. However, the threshold voltage was more than 2x higher at 9.2V. "The abnormally high Vth could be caused by a possible problem in the carrier transport, which is not understood at this moment," the team comments. These problems limited the temperature range of the devices.

The maximum cw output power of 14.3mW/facet at 80K with 172mA injection was around 4x that of the group's previous work. The wavelength was 10.2μm. In pulsed operation, the wavelength increased to 10.85μm at 137K.

The longer-wavelength material had wavelengths under pulsed operation varying from 12.7μm at 80K to 13.23μm at 115K. The 80K pulsed mode threshold was 179A/cm^2 for the current density, and 7.5V for voltage. These thresholds naturally rose at higher temperature.

Other devices from the same wafer were able to operate beyond 115K, up to 120K, but with slightly shorter wavelengths (Figure 2). The reduction in wavelength was blamed on band-filling effects: "As lasing emission is pushed toward longer wavelengths with increasing temperature, the waveguide loss rapidly increases and there also tends to be a reduced modal overlap with the gain medium." ■

https://doi.org/10.1063/5.0084565

Author: Mike Cooke

High-bandwidth membrane III–V lasers on SiO_2/Si

Researchers boost 3dB frequency by 26% to 60GHz, enabling 200-400Gbs performance for 2-channel system.

Nippon Telegraph and Telephone Corporation (NTT) and Waseda University in Japan have reported a 26% increase in 3dB bandwidth to 60GHz for its two-channel energy-efficient directly modulated membrane laser (DML) arrays on a silicon dioxide/silicon (SiO_2/Si) platform [Nikolaos-Panteleimon Diamantopoulos et al, IEEE Journal of Lightwave Technology, published online 23 February 2022].

Such arrays are being developed for higher data rates in data centers and high-performance computing systems linked by optical fiber. The 60GHz bandwidth brings in sight 200–400 gigabit per second (Gbps) transmission with simple modulation techniques.

DMLs on much more expensive high-thermal-conductivity silicon carbide (SiC) can achieve 108GHz 3dB bandwidths, but the team sees the deployment on silicon as "being a critical step towards achieving low-cost production via large silicon wafers".

The researchers increased the bandwidth by enhancing photon-photon resonance (PPR) effects through careful design of the longitudinal modes of the laser cavity.

The laser cavity consisted of a rear distributed Bragg reflector (DBR-r) that was detuned from one of the two main resonant wavelengths of the distributed feedback (DFB) section on the multiple quantum well structure (Figure 1). The front section consisted of a DBR (DBR-f) with a similar wavelength response as the DFB. The aim of the detuning was to single out the non-detuned wavelength.

The lengths of the sections were optimized to increase the PPR frequency to 50GHz, a 10GHz increase over the group's previous work. In particular, the DFB section length was reduced to 80μm from 100μm previously.

The membrane DBR laser consisted of a buried MQW heterostructure between lateral p- and n-type indium phosphide (InP), giving a PiN junction (Figure 2) on SiO2/Si substrate. The total thickness of the III–V membrane was 350nm. The laser structure itself consisted of a 600nm core of indium gallium aluminium arsenide (InGaAlAs) layers with 103nm MQW active region aimed at O-band operation (1260–1360nm). NTT/Waseda use selective-area growth on directly bonded InP on SiO_2/Si to produce such structures.

The light from the 2-laser array was coupled into standard single-mode fibers (SSMFs) using a spot-size converter consisting of an InP taper and SiO_x waveguide in SiO_2 cladding. The channels were separated at 250μm pitch to avoid electrical and thermal crosstalk.

The laser output under modulation varied with frequency for both devices at 25°C, falling by 3dB relative to the DC performance at around 60GHz. The 3dB bandwidth of the group's previous work was around 47GHz.

With a view to practical implementation, the team performed a number of short-reach tests using 112Gbps non-return to zero (NRZ) and 100GBaud four-level pulse-amplitude modulation (PAM-4) (200Gbps) signals. No crosstalk was detected between the

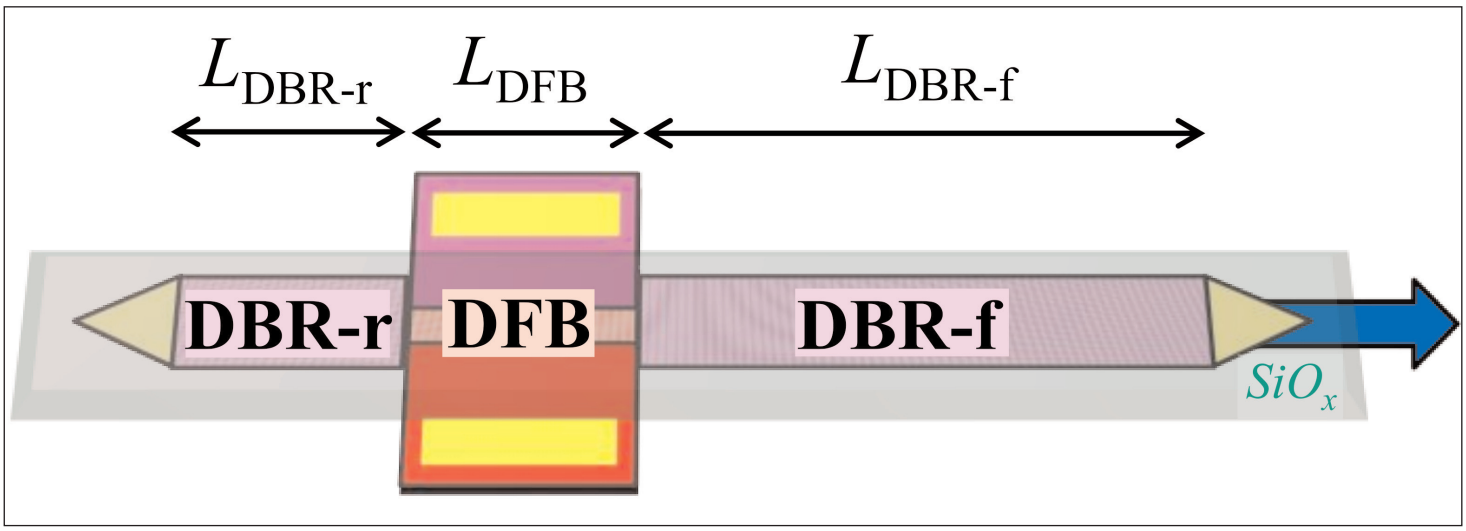


Figure 1. Longitudinal laser design for photon-photon resonance.

two channels. The operating powers for NRZ signals were around 26mW and 35mW for the separate devices. The difference in power was due to fabrication variations.

The bit-error rates (BERs) after NRZ transmission over 2km of SSMF met the standards for 200/400Gbps Ethernet with KP4 forward-error correction (KP4-FEC). The laser operating powers were equivalent to 0.24pJ/bit and 0.31pJ/bit for the respective channels, or 0.29pJ/bit combined.

The PAM-4 modulation did not manage the BER needed for KP4-FEC, but it did manage, with respective BERs of 1.58E−2 and 7.25E−3, the more relaxed threshold for hard-decision FEC (HD-FEC), but with higher power consumption and latency.

The researchers also considered the performance at up to 75°C with a view to implementations without special cooling systems. At the higher temperature, the 3dB bandwidth reduced to 45GHz, which could be adequate for 100Gbps-class PAM-4 signals, according to the team. The optimum bias current was increased slightly to 16.3mA from 14.1mA at 25°C. The researchers comment: "Since the bias current deviation is only within ±1.1mA, simple control electronics, typically found in DML transmitters, can be utilized as real-time adjustment mechanisms for the bias currents, without any need for costly and extra power-consuming heaters." ■

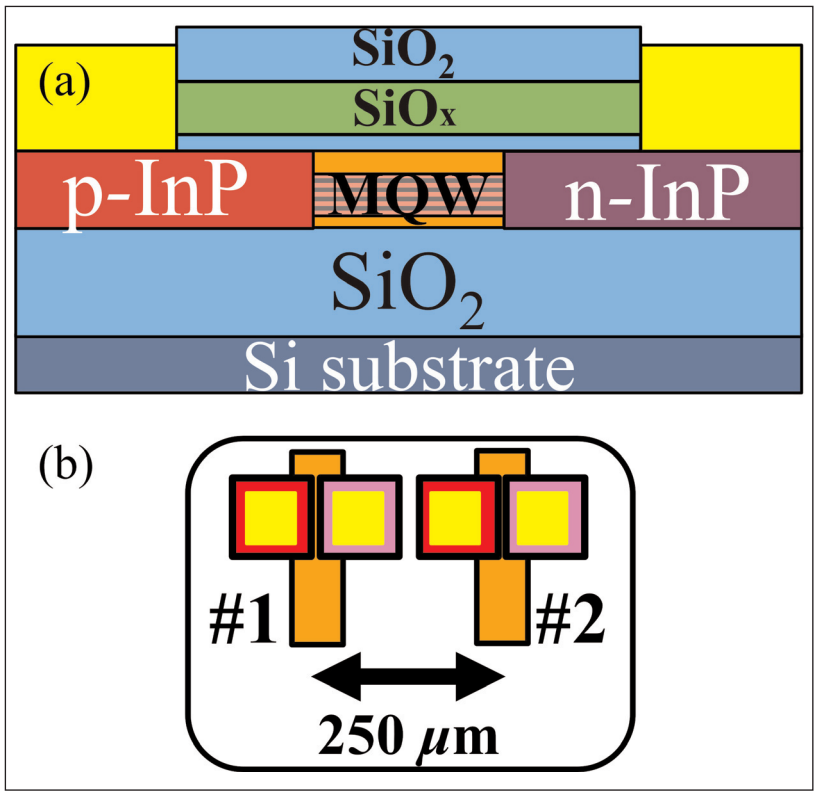


Figure 2. Fabricated laser array structure: (a) cross section; (b) two-channel laser array chiplet.

https://doi.org/10.1109/JLT.2022.3153648
Author: Mike Cooke

SiC device market growing at 34% CAGR from $1.09bn in 2021 to $6.3bn in 2027

Rising demand is driving capacity expansion and supply chain integration, says Yole Développement.

The global silicon carbide (SiC) device market is rising at a compound annual growth rate (CAGR) of 34% from $1.09bn in 2021 to $6.3bn by 2027, estimates market research and strategy consulting firm Yole Développement in its latest annual report 'Power SiC 2022'.

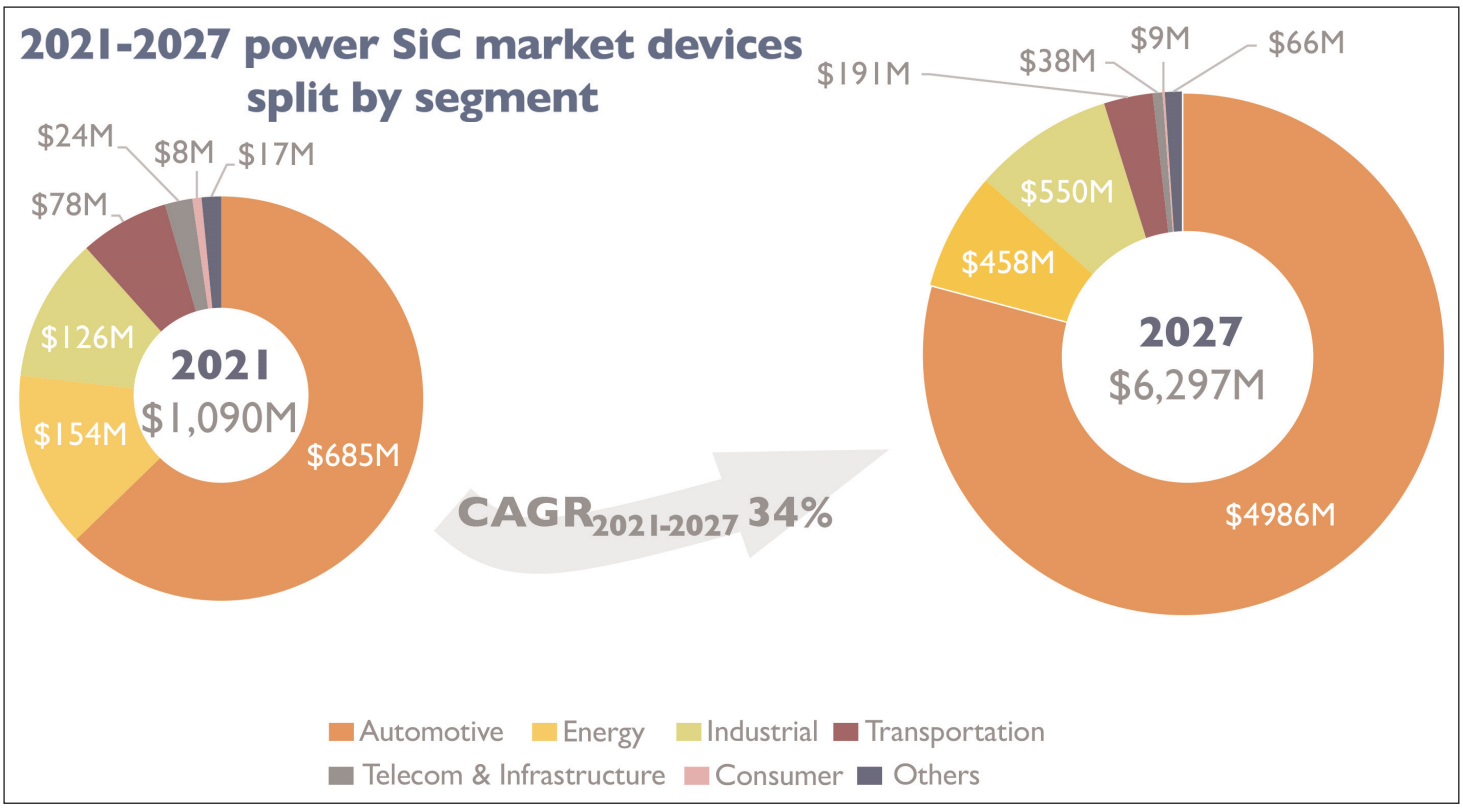
"Strongly driven by automotive applications, especially in the electric vehicle (EV) main inverter, there were multiple newly released EVs and announcements in 2020 and 2021, following Tesla's adoption of SiC," says Poshun Chiu, technology & market analyst specializing in Compound Semiconductor & Emerging Substrates, at Yole. "Moreover, Tesla's record shipments helped SiC devices to reach the order of $1bn in 2021," he adds. "To fulfill the demand for a long driving range, an 800V EV is the solution to empower fast direct current (DC) charging. This is where the 1200V SiC devices play crucial roles."

As of 2022, BYD's Han-EV and Hyundai's Ioniq-5 have enjoyed good sales by offering fast charging. More OEMs — such as Nio, XPeng, etc — plan to bring SiC EVs to the market in 2022.

Apart from automotive applications, industrial and energy applications — such as deployment of high-power charging infrastructure with SiC modules, and the growing installation of photovoltaics — represent markets with a growth rate of more than 20% during the forecast period.

Among the top SiC device players, STMicroelectronics and Wolfspeed grew their SiC revenue more than 50% year-on-year in 2021, aligning with the 57% growth in the global SiC device market. Infineon Technologies achieved 126% growth by entering the main inverter business, based on industrial applications. onsemi also entered the game, yielding strong growth in 2021.

As these companies grow SiC into billion-dollar businesses, competition in the coming years can also be identified in supply chain integration. The major



2020-2021 revenue - Top 6 SiC power device manufacturers

Rank	Area	Company	2020	2021	2020-2021 YoY growth
1	Europe	STMicroelectronics	$290M	$450M	55%
2	Europe	Infineon Technologies	$110M	$248M	126%
3	North America	Wolfspeed	$108M	$165M	53%
4	Asia	ROHM	$103M	$108M	5%
5	North America	onsemi	$55M	$78M	43%
6	Asia	Mitsubishi Electric	$26M	$28M	8%

2020-2021 global SiC device YoY growth: 57%

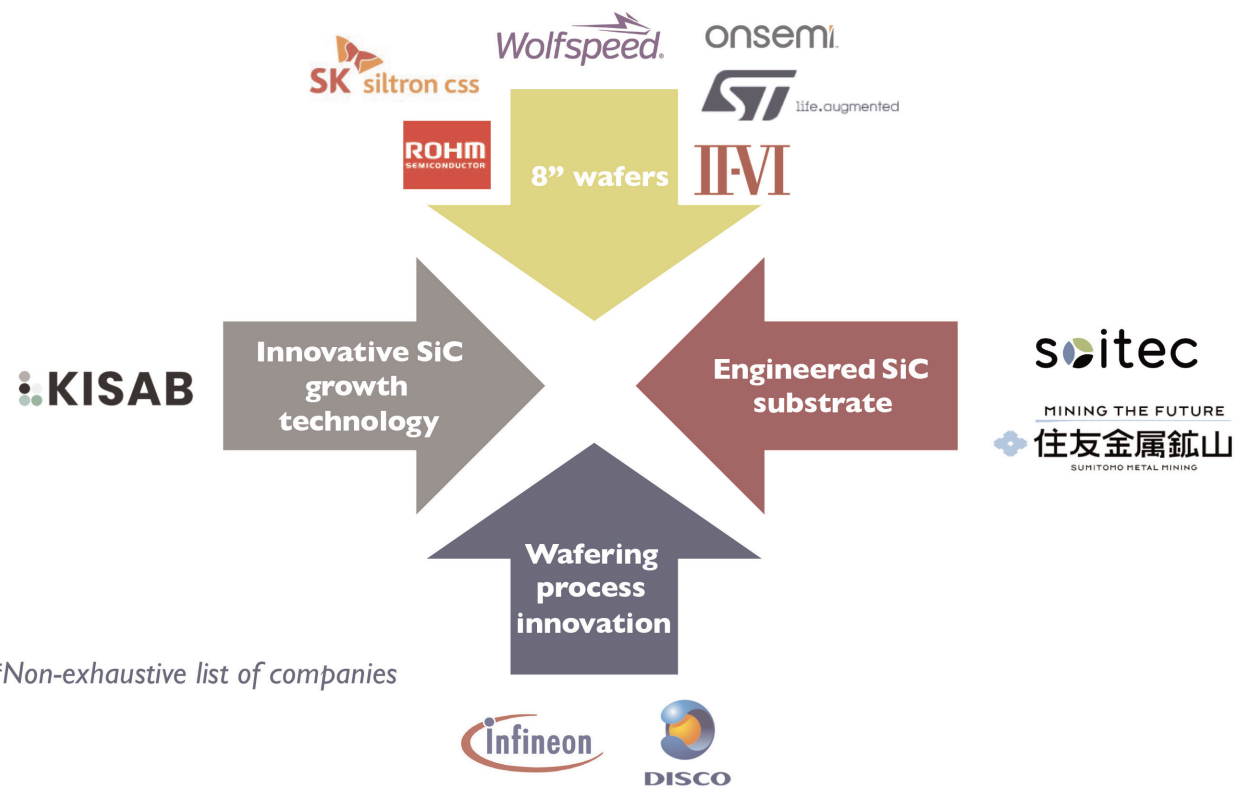
players have chosen IDM business models, and multiple mergers and acquisitions (M&As) and partnerships in silicon carbide have reshaped the SiC ecosystem. They aim to secure their wafer supply and enter the device business to sustain their billion-dollar business objectives in the years to come, adds Yole.

The next level for players to compete in is the SiC module, and Yole has identified new products being released for automotive, industrial and energy applications.

On 28 April, Dr Peter Friedrich (vice president SiC at Infineon Technologies) together with Poshun Chiu (technology & market analyst specializing in Compound Semiconductor & Emerging Substrates at Yole) and Amine Allouche (technology & cost analyst at System Plus Consulting) answered questions during a Yole webcast 'SiC evolution: Cars drive a multi-billion dollar business'. ■

www.i-micronews.com/products/power-sic-2022

Innovation of SiC wafer technology as of 2022*



*Non-exhaustive list of companies

suppliers' directory

Index

To have your company listed in this directory, e-mail details (including categories) to mark@semiconductor-today.com
Note: advertisers receive a free listing. For all other companies, a charge is applicable.

1 Bulk crystal source materials

Vital Materials Co Ltd (head office)
Floor 49, International Metropolitan Plaza,
68 Huacheng Avenue,
Tianhe District,
Guangzhou, Guangdong,
China 510623
Tel: +86 020-83511906
Fax: +86 020-83511907
E-mail: Sales@vitalchem.com
www.vitalchem.com
Vital Materials is the world's leading producer of rare metals as well as the first Chinese manufacturer to deliver G11 rotary ITO target. Vital is also one of the world's three major supplier of infrared materials, a key supplier of compound semiconductor substrates, and a strategic partner of the world's largest thin film solar manufacturer.

United Mineral & Chemical Corp
1100 Valley Brook Avenue,
Lyndhurst, NJ 07071, USA
Tel: +1 201 507 3300
Fax: +1 201 507 1506
www.umccorp.com

2 Bulk crystal growth equipment

Cyberstar
109 Rue Hilaire de Chardonnet — Technisud,
38100 Grenoble,
France
Tel: +33 (0)4 76 49 65 60
E-mail: cyberstar@cyberstar.fr
www.cyberstar.fr

3 Substrates

AXT Inc
4281 Technology Drive,
Fremont,
CA 94538, USA
Tel: +1 510 438 4700
Fax: +1 510 683 5901
www.axt.com

Crystal IS Inc
70 Cohoes Avenue,
Green Island,
NY 12183,
USA
Tel: +1 518 271 7375
Fax: +1 518 271 7394
www.crystal-is.com

CS Microelectronics Co Ltd (Vital Materials subsidiary)
Gaofeng Park,
Wanzhou Economic-Technological Development Area,
Chongqing,
China 404040
Tel: +86 023-58879888
E-mail: csm_sales@vitalchem.com
www.cs-micro.com
Vital Materials is the world's leading producer of rare metals as well as the first Chinese manufacturer to deliver G11 rotary ITO target. Vital is also one of the world's three major supplier of infrared materials, a key supplier of compound semiconductor substrates, and a strategic partner of the world's largest thin film solar manufacturer.

Freiberger Compound Materials
Am Junger Loewe Schacht 5,
Freiberg, 09599,
Germany
Tel: +49 3731 280 0
Fax: +49 3731 280 106
www.fcm-germany.com

Kyma Technologies Inc
8829 Midway West Road,
Raleigh, NC, USA
Tel: +1 919 789 8880
Fax: +1 919 789 8881
www.kymatech.com

MARUWA CO LTD
3-83, Minamihonjigahara-cho,
Owariasahi, Aichi 488-0044, Japan
Tel: +81 572 52 2317
www.maruwa-g.com/e/products/ceramic

sp3 Diamond Technologies
2220 Martin Avenue,
Santa Clara, CA 95050, USA
Tel: +1 877 773 9940
Fax: +1 408 492 0633
www.sp3inc.com

Sumitomo Electric Semiconductor Materials Inc
7230 NW Evergreen Parkway,
Hillsboro, OR 97124, USA
Tel: +1 503 693 3100 x207
Fax: +1 503 693 8275
www.sesmi.com

The Fox Group Inc
200 Voyageur Drive, Montreal,
Quebec H9R 6A8, Canada
Tel: +1 925 980 5645
Fax: +1 514 630 0227
www.thefoxgroupinc.com

III/V-Reclaim
Wald 10, 84568 Pleiskirchen,
Germany
Tel: +49 8728 911 093
Fax: +49 8728 911 156
www.35reclaim.de

TECDIA Inc
2700 Augustine Drive, Suite 110,
Santa Clara, CA 95054 , USA
Tel: +1 408 748 0100
Fax: +1 408 748 0111
Contact Person: Cathy W. Hung
E-mail: sales@tecdia.com
www.tecdia.com

Wafer Technology Ltd
34 Maryland Road, Tongwell,
Milton Keynes, Bucks, MK15 8HJ, UK
Tel: +44 (0)1908 210444
Fax: +44 (0)1908 210443
www.wafertech.co.uk

Wafer Technology Ltd is a UK based producer of III-V materials and epitaxy-ready substrates offering the widest product range in the business.

Wafer World Inc
1100 Technology Place, Suite 104,
West Palm Beach,
FL 33407,
USA
Tel: +1-561-842-4441
Fax: +1-561-842-2677
www.waferworld.com

4 Epiwafer foundry

Albemarle Cambridge Chemical Ltd
Unit 5 Chesterton Mills,
French's Road, Cambridge CB4 3NP,
UK
Tel: +44 (0)1223 352244
Fax: +44 (0)1223 352444
www.camchem.co.uk

Intelligent Epitaxy Technology Inc
1250 E Collins Blvd,
Richardson, TX 75081-2401,
USA
Tel: +1 972 234 0068
Fax: +1 972 234 0069
www.intelliepi.com

IQE
Cypress Drive,
St Mellons,
Cardiff
CF3 0EG, UK
Tel: +44 29 2083 9400
Fax: +44 29 2083 9401
www.iqep.com
IQE is a leading global supplier of advanced epiwafers, with products covering a diverse range of applications within the wireless, optoelectronic, photovoltaic and electronic markets.

OMMIC
2, Chemin du Moulin B.P. 11,
Limeil-Brevannes, 94453,
France
Tel: +33 1 45 10 67 31
Fax: +33 1 45 10 69 53
www.ommic.fr

Soitec
Parc Technologique des Fontaines,
Chemin des Franques, 38190
Bernin, France
Tel: +33 (0)4 76 92 75 000
www.soitec.com

The Fox Group Inc
200 Voyageur Drive, Montreal,
Quebec H9R 6A8, Canada
Tel: +1 925 980 5645
Fax: +1 514 630 0227
www.thefoxgroupinc.com

VIGO SYSTEM S.A.
ul. Poznanska 129 /133, 05-850
Ozarów Mazowiecki, Poland
Tel: +48 22 733 54 10
E-mail: ent@vigo.com.pl
ent-epitaxy.com

www.vigo.com.pl www.ent-epitaxy.com

VIGO System's Epitaxy Division produces high-grade III–V compound semiconductor epitaxial structures for photonic and microelectronic devices. With more than 35 years' experience, the division offers a broad range of epi-wafers, both in large volumes and small customised batches. It focuses on innovative products for wireless, TC, sensing or printing applications.

5 Deposition materials

Materion Advanced Materials Group
2978 Main Street,
Buffalo, NY 14214,
USA
Tel: +1 716 837 1000
Fax: +1 716 833 2926
www.williams-adv.com

Matheson Tri-Gas
6775 Central Avenue,
Newark, CA 94560,
USA
Tel: +1 510 793 2559
Fax: +1 510 790 6241
www.mathesontrigas.com

Nouryon Functional Chemicals B.V.
Zutphenseweg 10, 7418 AJ
Deventer,
The Netherlands
Tel. +31 652 478554
https://hpmo.nouryon.com

Praxair Electronics
542 Route 303,
Orangeburg,
NY 10962,
USA
Tel: +1 845 398 8242
Fax: +1 845 398 8304
www.praxair.com/electronics

Vital Thin Film Materials (Guangdong) Co Ltd (Vital Materials subsidiary)
18G, 18th Floor, Shenzhen Free Trade Centre, No.111 Taizi Road,
Nanshan District,
Shenzhen, Guangdong, China 518067
Tel: (+86) 0755-21651348
sales@vitaltfm.com
www.vitaltfm.com
Vital Materials is the world's leading producer of rare metals as well as the first Chinese manufacturer to deliver G11 rotary ITO target. Vital is also one of the world's three major supplier of infrared materials, a key supplier of compound semiconductor substrates, and a strategic partner of the world's largest thin film solar manufacturer.

6 Deposition equipment

AIXTRON SE
Dornkaulstr. 2,
52134 Herzogenrath,
Germany
Tel: +49 2407 9030 0
Fax: +49 2407 9030 40
www.aixtron.com

ETC (LPE subsidiary)
Via Falzarego, 820021 Baranzate (Mi),
Italy
Tel: +39 02 383 41 51
Fax: +39 02 383 06 118
www.lpe-epi.com

Evatec AG
Hauptstrasse 1a,
CH-9477 Trübbach,
Switzerland
Tel: +41 81 403 8000
Fax: +41 81 403 8001
www.evatecnet.com

FHR Anlagenbau Gmbh (Vital Materials subsidiary)
Am Hügel 2, D-01458
Ottendorf-Okrilla,
Germany
Tel: +49 35205 520-0
E-mail: sales@fhr.de
E-mail: sales@vitalchem.com
www.fhr.biz
Vital Materials is the world's leading producer of rare metals as well as the first Chinese manufacturer to deliver G11 rotary ITO target. Vital is also one of the world's three major supplier of infrared materials, a key supplier of compound semiconductor substrates, and a strategic partner of the world's largest thin film solar manufacturer.

LPE S.p.A.
Via Falzarego, 8
20021 Baranzate (Mi), Italy
Tel: +39 02 383 41 51
Fax: +39 02 383 06 118
www.lpe-epi.com

PLANSEE High Performance Materials
6600 Reutte,
Austria
Tel: +43 5672 600 2422
info@plansee.com
www.plansee.com

Plasma-Therm LLC
10050 16th Street North,
St. Petersburg, FL 33716,
USA
Tel: +1 727 577 4999
Fax: +1 727 577 7035
www.plasmatherm.com

Riber
31 rue Casimir Périer, BP 70083,
95873 Bezons Cedex,
France
Tel: +33 (0) 1 39 96 65 00
Fax: +33 (0) 1 39 47 45 62
www.riber.com

SVT Associates Inc
7620 Executive Drive,
Eden Prairie, MN 55344, USA
Tel: +1 952 934 2100
Fax: +1 952 934 2737
www.svta.com

Temescal, a division of Ferrotec
4569-C Las Positas Rd,
Livermore, CA 94551, USA
Tel: +1 925 245 5817
Fax: +1 925 449-4096
www.temescal.net

Veeco Instruments Inc
100 Sunnyside Blvd.,
Woodbury, NY 11797, USA
Tel: +1 516 677 0200
Fax: +1 516 714 1231
www.veeco.com

7 Wafer processing materials

Kayaku Advanced Materials Inc
200 Flanders Road,
Westborough, MA 01581, USA
Tel: +1 617 965 5511
www.kayakuam.com

Praxair Electronics
(see section 5 for full contact details)

Versum Materials
8555 S. River Parkway,
Tempe, AZ 85284, USA
Tel: +1 602 282 1000
www.versummaterials.com

8 Wafer processing equipment

Evatec AG
Hauptstrasse 1a, CH-9477 Trübbach,
Switzerland
Tel: +41 81 403 8000
Fax: +41 81 403 8001
www.evatecnet.com

EV Group
DI Erich Thallner Strasse 1,
St. Florian/Inn, 4782,
Austria
Tel: +43 7712 5311 0
Fax: +43 7712 5311 4600
www.EVGroup.com

EV Group is a technology and market leader for wafer processing equipment. Worldwide industry standards for aligned wafer bonding, resist processing forthe MEMS, nano and semiconductor industry.

Logitech Ltd
Erskine Ferry Road,
Old Kilpatrick, near Glasgow G60 5EU,
Scotland, UK
Tel: +44 (0) 1389 875 444
Fax: +44 (0) 1389 879 042
www.logitech.uk.com

Plasma-Therm LLC
(see section 6 for full contact details)

SAMCO International Inc
532 Weddell Drive,
Sunnyvale, CA,
USA
Tel: +1 408 734 0459
Fax: +1 408 734 0961
www.samcointl.com

SPTS Technology Ltd
Ringland Way,
Newport NP18 2TA, UK
Tel: +44 (0)1633 414000
Fax: +44 (0)1633 414141
www.spts.com

SUSS MicroTec AG
Schleißheimer Strasse 90,
85748 Garching, Germany
Tel: +49 89 32007 0
Fax: +49 89 32007 162
www.suss.com

Synova SA
Ch. de la Dent d'Oche,
1024 Ecublens, Switzerland
Tel +41 21 694 35 00
Fax +41 21 694 35 01
www.synova.ch

TECDIA Inc
2700 Augustine Drive, Suite 110,
Santa Clara, CA 95054 , USA
Tel: +1-408-748-0100
Fax: +1-408-748-0111
Contact Person: Cathy W. Hung
Email: sales@tecdia.com
www.tecdia.com

Veeco Instruments Inc
(see section 6 for full contact details)

9 Materials & metals

Goodfellow Cambridge Ltd
Ermine Business Park, Huntingdon,
Cambridgeshire PE29 6WR, UK
Tel: +44 (0) 1480 424800
Fax: +44 (0) 1480 424900
www.goodfellow.com

PLANSEE High Performance Materials
6600 Reutte, Austria
Tel: +43 5672 600 2422
info@plansee.com
www.plansee.com

TECDIA Inc
2700 Augustine Drive, Suite 110,
Santa Clara, CA 95054,
USA
Tel: +1 408 748 0100
Fax: +1 408 748 0111
www.tecdia.com

10 Gas and liquid handling equipment

Cambridge Fluid Systems
12 Trafalgar Way, Bar Hill,
Cambridge CB3 8SQ,
UK
Tel: +44 (0)1954 786800
Fax: +44 (0)1954 786818
www.cambridge-fluid.com

CS CLEAN SOLUTIONS AG
Fraunhoferstrasse 4,
Ismaning, 85737,
Germany
Tel: +49 89 96 24000
Fax: +49 89 96 2400122
www.csclean.com

Entegris Inc
129 Concord Road,
Billerica, MA 01821, USA
Tel: +1 978 436 6500
Fax: +1 978 436 6735
www.entegris.com

IEM Technologies Ltd
Fothergill House, Colley Lane,
Bridgwater, Somerset TA6 5JJ, UK
Tel: +44 (0)1278 420555
Fax: +44 (0)1278 420666
www.iemtec.com

Vacuum Barrier Corporation
4 Barton Lane,
Woburn, MA 01801,
USA
Tel: +1 781 933 3570
Fax: +1 781 933 9428
www.vacuumbarrier.com

VACUUM BARRIER VBC CORPORATION

Vacuum Barrier's vacuum-jacketed dynamic and sealed SEMIFLEX LN2 pipe delivers LN2 at bulk tank pressure in two-phase condition for on-demand supply. Our liquid/vapor phase separators deliver low-pressure LN2 to each use point for on-demand supply. Combine with SEMIFLEX Triax LN2 pipe eliminates two-phase flow to all use points.

Versum Materials
8555 S. River Parkway,
Tempe, AZ 85284,
USA
Tel: +1 602 282 1000
www.versummaterials.com

11 Process monitoring and control

Conax Technologies
2300 Walden Avenue,
Buffalo, NY 14225,
USA
Tel: +1 800 223 2389
Tel: +1 716 684 4500
www.conaxtechnologies.com

k-Space Associates Inc
2182 Bishop Circle
East, Dexter,
MI 48130,
USA
Tel: +1 734 426 7977
Fax: +1 734 426 7955
www.k-space.com

KLA-Tencor
One Technology Dr,
1-2221I, Milpitas,
CA 95035,
USA
Tel: +1 408 875 3000
Fax: +1 408 875 4144
www.kla-tencor.com

LayTec AG
Seesener Str. 10–13,
10709 Berlin,
Germany
Tel: +49 30 89 00 55 0
Fax: +49 30 89 00 180
www.laytec.de
LayTec develops and manufactures optical in-situ and in-line metrology systems for thin-film processes with particular focus on compound semiconductor and photovoltaic applications. Its know-how is based on optical techniques: reflectometry, emissivity corrected pyrometry, curvature measurements and reflectance anisotropy spectroscopy.

Vacuum Barrier Corporation
4 Barton Lane, Woburn, MA 01801,
USA
Tel: +1 781 933 3570
Fax: +1 781 933 9428
www.vacuumbarrier.com
Vacuum Barrier's vacuum-jacketed dynamic and sealed SEMIFLEX LN2 pipe delivers LN_2 at bulk tank pressure in two-phase condition for on-demand supply. Our liquid/vapor phase separators deliver low-pressure LN_2 to each use point for on-demand supply. Combine with SEMIFLEX Triax LN_2 pipe eliminates two-phase flow to all use points.

WEP (Ingenieurbüro Wolff für Elektronik- und Programmentwicklungen)
Bregstrasse 90,
D-78120 Furtwangen im Schwarzwald, Germany
Tel: +49 7723 9197 0
Fax: +49 7723 9197 22
www.wepcontrol.com

12 Inspection equipment

Bruker
Oestliche Rheinbrueckenstrasse 49,
Karlsruhe, 76187, Germany
Tel: +49 (0)721 595 2888
Fax: +49 (0)721 595 4587
www.bruker.com

KLA–Tencor
160 Rio Robles, Suite 103D,
San Jose, CA 94538-7306, USA
Tel: +1 408 875-3000
Fax: +1 510 456-2498
www.kla-tencor.com

13 Characterization equipment

J.A. Woollam Co. Inc.
645 M Street Suite 102,
Lincoln, NE 68508, USA
Tel: +1 402 477 7501
Fax: +1 402 477 8214
www.jawoollam.com

Lake Shore Cryotronics Inc
575 McCorkle Boulevard,
Westerville, OH 43082, USA
Tel: +1 614 891 2244
Fax: +1 614 818 1600
www.lakeshore.com

14 Chip test equipment

Riff Company Inc
1484 Highland Avenue, Cheshire,
CT 06410, USA
Tel: +1 203-272-4899
Fax: +1 203-250-7389
www.riff-co.com

Tektronix Inc
14150 SW Karl Braun Drive,
P.O.Box 500, OR 97077, USA
www.tek.com

15 Assembly/packaging materials

ePAK International Inc
4926 Spicewood Springs Road,
Austin, TX 78759,
USA
Tel: +1 512 231 8083
Fax: +1 512 231 8183
www.epak.com

Gel-Pak
31398 Huntwood Avenue,
Hayward, CA 94544,
USA
Tel: +1 510 576 2220
Fax: +1 510 576 2282
www.gelpak.com

Wafer World Inc
(see section 3 for full contact details)

Materion Advanced Materials Group
2978 Main Street,
Buffalo, NY 14214,
USA
Tel: +1 716 837 1000
Fax: +1 716 833 2926
www.williams-adv.com

16 Assembly/packaging equipment

CST Global Ltd
4 Stanley Boulevard,
Hamilton International Technology Park,
Blantyre, Glasgow G72 0BN,
UK
Tel: +44 (0) 1698 722072
www.cstglobal.uk

Kulicke & Soffa Industries
1005 Virginia Drive,
Fort Washington,
PA 19034,
USA
Tel: +1 215 784 6000
Fax: +1 215 784 6001
www.kns.com

Palomar Technologies Inc
2728 Loker Avenue West,
Carlsbad, CA 92010,
USA
Tel: +1 760 931 3600
Fax: +1 760 931 5191
www.PalomarTechnologies.com

PI (Physik Instrumente) L.P.
16 Albert St . Auburn ,
MA 01501, USA
Tel: +1 508-832-3456,
Fax: +1 508-832-0506
www.pi.ws
www.pi-usa.us

TECDIA Inc
2700 Augustine Drive, Suite 110,
Santa Clara,
CA 95054,
USA
Tel: +1 408 748 0100
Fax: +1 408 748 0111
www.tecdia.com

17 Assembly/packaging foundry

Quik-Pak
10987 Via Frontera,
San Diego, CA 92127, USA
Tel: +1 858 674 4676
Fax: +1 8586 74 4681
www.quikicpak.com

18 Chip foundry

CST Global Ltd
4 Stanley Boulevard, Hamilton International Technology Park,
Blantyre, Glasgow, G72 0BN,
UK
Tel: +44 (0) 1698 722072
www.cstglobal.uk

United Monolithic Semiconductors
Route departementale 128,
BP46, Orsay, 91401,
France
Tel: +33 1 69 33 04 72
Fax: +33 169 33 02 92
www.ums-gaas.com

19 Facility equipment

RENA Technologies NA
3838 Western Way NE,
Albany, OR 97321, USA
Tel: +1 541 917 3626
www.rena-na.com

Vacuum Barrier Corporation
4 Barton Lane, Woburn, MA 01801,
USA
Tel: +1 781 933 3570
Fax: +1 781 933 9428
www.vacuumbarrier.com

VACUUM BARRIER VBC CORPORATION

Vacuum Barrier's vacuum-jacketed dynamic and sealed SEMIFLEX LN2 pipe delivers LN_2 at bulk tank pressure in two-phase condition for on-demand supply. Our liquid/vapor phase separators deliver low-pressure LN_2 to each use point for on-demand supply. Combine with SEMIFLEX Triax LN_2 pipe eliminates two-phase flow to all use points.

20 Facility consumables

PLANSEE High Performance Materials
6600 Reutte,
Austria
Tel: +43 5672 600 2422
info@plansee.com
www.plansee.com

W.L. Gore & Associates
401 Airport Rd, Elkton,
MD 21921-4236,
USA
Tel: +1 410 392 4440
Fax: +1 410 506 8749
www.gore.com

21 Computer hardware & software

Crosslight Software Inc
121-3989 Henning Dr.,
Burnaby, BC, V5C 6P8,
Canada
Tel: +1 604 320 1704
Fax: +1 604 320 1734
www.crosslight.com

Semiconductor Technology Research Inc
10404 Patterson Ave.,
Suite 108, Richmond,
VA 23238,
USA
Tel: +1 804 740 8314
Fax: +1 804 740 3814
www.semitech.us

22 Used equipment

Brumley South Inc
422 North Broad Street,
Mooresville,
NC 28115,
USA
Tel: +1 704 664 9251
Email: sales@brumleysouth.com
www.brumleysouth.com

BSI

As an ISO 9001 registered global leader in the remanufacturing of wafer inspection systems, Brumley South Inc specializes in designing, installing and supporting upgrades for ADE, Nanometrics, Dryden and KLA-Tencor Surfscan tools, polysterene latex sphere calibration standards, particle deposition systems, and semiconductor parts and service.

Class One Equipment Inc
5302 Snapfinger Woods Drive,
Decatur, GA 30035,
USA
Tel: +1 770 808 8708
Fax: +1 770 808 8308
www.ClassOneEquipment.com

23 Services

Riff Company Inc
1484 Highland Avenue,
Cheshire, CT 06410,
USA
Tel: +1 203-272-4899
Fax: +1 203-250-7389
www.riff-co.com

TECDIA Inc
2700 Augustine Drive, Suite 110,
Santa Clara,
CA 95054 ,
USA
Tel: +1-408-748-0100
Fax: +1-408-748-0111
Contact Person: Cathy W. Hung
www.tecdia.com

24 Resources

Al Shultz Advertising Marketing for Advanced Technology Companies
1346 The Alameda,
7140 San Jose,
CA 95126, USA
Tel: +1 408 289 9555
www.alshuktz.com

SEMI Global Headquarters
San Jose, CA 95134,
USA
Tel: +1 408 943 6900
www.semi.org

Yole Développement
69006 Lyon,
France
Tel: +33 472 83 01 86
www.yole.fr

event calendar

If you would like your event listed in *Semiconductor Today*'s Event Calendar, then please e-mail all details to the Editor at mark@semiconductor-today.com

3–6 May 2022
45th WOCSDICE — Workshop on Compound Semiconductor Devices and Integrated Circuits held in Europe & 16th EXMATEC — Expert Evaluation and Control of Compound Semiconductor Materials and Technologies (WOCSDICE EXMATEC 2022)
Ponta Delgada (São Miguel island - Azores), Portugal
E-mail: WE2022@ua.pt
https://we2022.av.it.pt

4–6 May 2022
23rd European Conference on Integrated Optics (ECIO 2022)
Politecnico di Milano, Milan, Italy
E-mail: info@ecio-conference.org
www.ecio-conference.org

9 May 2022
36th annual Reliability of Compound Semiconductors Workshop (ROCS 2022)
Monterey Marriott & Conference Center, CA, USA
E-mail: rocs@jedec.org
www.jedec.org/events-meetings/rocs-workshop

9–12 May 2022
2022 CSMANTECH (International Conference on Compound Semiconductor Manufacturing Technology)
Monterey Marriott & Conference Center, Monterey, CA, USA
E-mail: chairman@csmantech.org
www.csmantech.org

10–12 May 2022
PCIM (Power Conversion and Intelligent Motion) Europe 2022
Nuremberg, Germany
E-mail: pcim@mesago.com
www.mesago.de/en/PCIM/main.htm

12–13 May 2022
Collaboration and innovation across the CS supply chain (CoInnovateCS)
Monterey Marriott & Conference Center, CA, USA
E-mail: events@csconnected.com
www.coinnovatecs.com

15–20 May 2022
2022 Conference on Lasers & Electro-Optics (CLEO)
San Jose Convention Center, San Jose, CA, USA
E-mail: CLEO@compusystems.com
www.cleoconference.org

22–26 May 2022
International Symposium on Power Semiconductor Devices and ICs (ISPSD 2022)
Marriott Pinnacle Downtown Hotel, Vancouver, Canada
E-mail: ngwt@vrg.utoronto.ca
www.ispsd2022.com

30 May – 3 June 2022
IEEE 72nd Electronic Components and Technology Conference (ECTC 2022)
The Sheraton San Diego Hotel and Marina, San Diego, CA, USA
E-mail: reg.ectc@gmail.com
www.ectc.net

advertisers' index

13–17 June 2022
2022 IEEE VLSI Symposium on Technology & Circuits — Technology and Circuits for the Critical Infrastructure of the Future
Hilton Hawaiian Village,
Honolulu, HI, USA
E-mail: vlsi@vlsisymposium.org
www.vlsisymposium.org

19–24 June 2022
IEEE MTT-S International Microwave Symposium (IMS2022) and Microwave Week
Colorado Convention Center,
Denver, CO, USA
E-mail: iMS@xpressreg.net
www.ims-ieee.org

21–23 June 2022
Lightfair 2022
Las Vegas Convention Center,
Las Vegas, USA
E-mail: michellem@lightfair.com
www.lightfair.com/las-vegas-2022

10–14 July 2022
(postponed from 14-19 June 2020, then 4-9 July 2021)
20th International Conference on Metal Organic Vapor Phase Epitaxy (ICMOVPE XX)
Schwabenlandhalle Fellbach, Stuttgart, Germany
E-mail: info@icmovpexx.eu
www.icmovpexx.eu

13–15 July 2022
LASER World of PHOTONICS CHINA
Shanghai, China
E-mail: info@world-of-photonics-china.com
www.world-of-photonics-china.com/en

21–25 July 2022
3rd International Congress on Advanced Materials Sciences and Engineering (AMSE-2022)
Hotel Ambasador, Opatija,
Croatia
E-mail: eve4@amse-materials2021.com
www.istci.org/amse2022

21–25 August 2022
SPIE Optics + Photonics 2022
San Diego Convention Center,
San Diego, CA, USA
E-mail: customerservice@spie.org
www.spie.org/opstm

31 August – 2 September 2022
PCIM (Power Conversion, Intelligent Motion) Asia 2022
Shanghai New International Expo Centre, China
E-mail: pcimasia@china.messefrankfurt.com
www.pcimasia-expo.com

7–9 September 2022
CIOE 2022
(24th China International Optoelectronic Exposition)
Shenzhen World Exhibition & Convention Center, China
E-mail: cioe@cioe.cn
www.cioe.cn/en

11–16 September 2022
19th International Conference on Silicon Carbide and Related Materials (ICSCRM 2022)
Davos, Switzerland
E-mail: info@icscrm2022.org
www.icscrm2022.org

19–21 September 2022
48th European Conference on Optical Communication (ECOC 2022)
Basel, Switzerland
E-mail: info@ecoc2020.org
www.ecoco2020.org

25–30 September 2022
25th European Microwave Week (EuMW 2022) including:
52nd European Microwave Conference (EuMC 2022)
17th European Microwave Integrated Circuits Conference (EuMIC 2022)
19th European Radar Conference (EuRAD 2022)
Milano Convention Centre (MICO), Milan, Italy
E-mail: rvaughan@horizonhouse.co.uk
www.eumweek.com

16–19 October 2022
2022 IEEE BiCMOS and Compound Semiconductor Integrated Circuits and Technology Symposium (BCICTS)
Sheraton Phoenix Downtown, Phoenix, AZ, USA
E-mail: cs@cshawevent.com
www.bcicts.org

16–21 October 2022
International Workshop on Bulk Nitride Semiconductors — XI (IWBNS-XI)
Lehigh Valley, PA, USA
E-mail: iwbns-xi@gmail.com
www.iwbns-xi.org

semiconductorTODAY

COMPOUNDS & ADVANCED SILICON

www.semiconductor-today.com

Join our LinkedIn group: Semiconductor Today

Follow us on Twitter: Semiconductor_T

Choose *Semiconductor Today* for . . .

MAGAZINE

Accurate and timely coverage of the compound semiconductor and advanced silicon industries

Targeted 82,000+ international circulation

Published 10 times a year and delivered by e-mail and RSS feeds

WEB SITE

Average of over 26,000 unique visitors to the site each month

Daily news updates and regular feature articles

Google-listed news source

E-BRIEF

Weekly round-up of key business and technical news

E-mail delivery to entire circulation

Banner and text marketing opportunities available